PRACTICAL ANATOMY

MUSTAFI'S

PRACTICAL ANATOMY

EDITED BY

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WITH NUMEROUS COLOURED ILLUSTRATIONS

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PREFACE TO THE THIRD EDITION

In this edition the entire text has been revised and rewritten, and considerable new matter has been added. Lucidity of arrangement and description which was the main feature of the book in previous editions, has been rigidly followed in the preparation of the present edition. "Directions" and "Dissections," embodying all instructions for practical work, have been fully given in separate paragraphs, while descriptive anatomy has been separately dealt with in complete detail. At the end of each Section, Tables of the Arteries, Veins and Nerves have been inserted which will be of great help to the student in his revision work.

Numerous illustrations of dissections, true to nature, and mostly coloured, have been inserted--these will act as valuable guides in the dissecting-room-work.

The "Basle" Terminology has been used as in the previous edition, but the old names have also been retained alongside within brackets.

I must express my profound obligations to those authors from whose works the illustrations have been borrowed, and each diagram has been gratefully acknowledged in the course of the book

NANI LAL PAN

MEDICAL COLLEGE, CALCUTTA
October, 1924

CONTENTS

THE SUPERIOR EXTREMITY

THE INFERIOR EXTREMITY

12th and subsequent days

The dissector of the *Abdomen* will then complete the study of the abdominal wall, the peritoneum, great vessels and nerves, abdominal and pelvic viscera, pelvic fascia and ligaments.

The dissector of the *Thorax* does not begin work until the twelfth day. He is to dissect the intercostal muscles, vessels, and nerves carefully, also the ligaments and cartilages, &c., as well as the pleuræ, heart, lungs, blood vessels and nerves connected therewith.

He should study the Diaphragm in conjunction with the dissector of the *Abdomen*.

The dissectors of the detached parts will work at their parts in the order detailed in the Practical Anatomy.

The Dissection of the *Head and Neck* takes at least EIGHT WEEKS.

The dissection of the *Superior Extremity* takes at least THREE WEEKS.

The Dissection of the *Inferior Extremity* takes at least THREE WEEKS.

The Dissection of the *Abdomen* and *Pelvis* takes at least FOUR WEEKS.

The Dissection of the *Thorax* takes at least TWO WEEKS.

THE ABDOMEN

Before the body is put in the lithotomy position for the dissection of the perineum the student should prac ise the passing of the catheter along the urethra into the bladder. In the *male subject,* he should stand on the left side of the body and having oiled the catheter, should pass it gently along the canal of the urethra, holding up the penis with the left hand. The instrument, when its tip is first introduced, has its concavity turned towards the left groin. As the end of the catheter is pressed further downwards the handle is carried gradually to the middle line of the body; when four or five inches of the instrument have been introduced it will be found that the end of it cannot be further pressed downwards. The handle of the instrument is now to be raised from the anterior abdominal wall till it is at right angles. Then the handle is to be depressed between the thighs when the end of the instrument will slip into the bladder. If some resistance is felt while depressing the handle of the instrument, introduce the left forefinger into the rectum to guide the point of the catheter along the remaining portion of the urethra to the bladder.

In the *female subject* the catheter can be easily passed owing to the short and simple course of the urethra.

THE PERINEUM

Three days should be devoted to the dissection of this region. The body should be put in the lithotomy position and the scrotum raised and tied to the handle of the catheter. The latter should be fixed to the cross-bar of the Perineal Block passing behind the knee joints or to a string tied round the body just below the iliac crests. A little tow or cotton wool is to be introduced into the rectum and the anal aperture sewn up. The student will see that the perineal space corresponds to the outlet of the pelvis. He should now study this portion of the pelvis from the skeleton hanging in the dissecting-room or preferably from a pelvis in which the ligaments have been preserved. In the latter, the space is bounded *in front* by the symphysis pubis and the arcuate pubic ligament; *on either side* by the inferior rami of the os pubis and ischium, the ischial tuberosity, and the sacrotuberous liga-

ment ; and *behind* by the tip of the coccyx. These boundaries the student should now try to identify in the subject he is going to dissect. If a transverse line is drawn from the front of one ischial tuberosity to the other, the space is subdivided into two triangular portions — an *anterior triangle* containing the urethra and the external genital organs, called the *urogenital triangle*, and a *posterior triangle* containing the anal canal, called the *anal triangle*.

THE MALE PERINEUM

On the surface of the body the perineal space in the male is limited by the scrotum in front, by the thighs on the sides, and by the buttocks behind. In the middle line a longitudinal cutaneous ridge is seen called the *median raphe of the perineum*. The raphe begins from the front of the anal orifice and passes over the scrotum showing the line of fusion of its two halves ; it can then be traced along the inferior surface of the penis.

THE ANAL TRIANGLE

Dissection. The following *incisions* are required : (1) a transverse incision in front of the anus connecting the anterior parts of the two ischial tuberosities ; (2) a vertical incision from the coccyx to the middle point of the transverse incision encircling the anal aperture in its course. Reflect the flaps of the skin lateralwards from the middle line.

Reflection of skin. In reflecting the skin the dissector should distinctly bear in mind that he is to separate it carefully from the underlying tissue. He is not to take away with the skin the tissue lying next to it which consists of the superficial fascia containing fat and cutaneous vessels and nerves. Herein the dissection of skin differs entirely from the making of a flap by the surgeon in which he removes a large amount of underlying tissues along with the skin so that the vascular and nerve supply of the flap is maintained. To reflect the skin the following procedure should be adopted :—Commence from the meeting-point of two lines of incision ; first put the point of the scalpel over this meeting-point and hold the scalpel at right angles to the skin ; then cut through the skin and as soon as the yellowish white superficial fascia is reached the blade is to be held at an acute angle. Having prepared one of the corners, hold it

with the forceps and detach the skin by the scalpel, always carrying its edge against the skin and leaving the fat behind with the superficial fascia. Care should be taken to avoid making punctures in the skin while the edge of the scalpel is carried against it. A uniform pitted appearance is presented on the inner surface of the skin if it is properly reflected. A little later the use of the forceps can be dispensed with and the detached skin may be held between the thumb and index finger.

In reflecting the skin from the margin of the anus some involuntary muscle fibres will be seen radiating from the anal orifice to the skin around it. These constitute the *corrugator cutis ani.* The *action* of this muscle is to raise into ridges the skin around the anal aperture.

The **Superficial Fascia** covers the whole body and lies under the skin. It contains fat and the cutaneous vessels and nerves. Beneath the superficial fascia but over the muscles is another layer of fibrous tissue devoid of fat ; this membranous sheet is called the **Deep Fascia.** The superficial fascia is placed between the skin and deep fascia and is attached to both by fibrous bands which make their way through the fat.

The *superficial fascia of the anal region* is very thick and contains a large amount of fat in its meshes specially in the space called the ischiorectal fossa.

Dissection. The sphincter ani externus is to be cleaned ; it is to be traced from the tip of the coccyx, then around the anal aperture to a tendinous point in front of the anus—the central tendinous point of the perineum. The ischiorectal fossa is next to be properly cleaned. Define the inferior margin of the glutæus maximus and also the margin of the sacrotuberous ligament covered by the muscle. Remove the fat filling the space between the anal canal, the inferior margin of the glutæus maximus and the tuber ischii, taking care to secure the following structures :—(1) the inferior hæmorrhoidal vessels and nerve, which pass across the fossa through the fat, from the lateral to the medial wall of the fossa ; (2) the perineal branch of the fourth sacral nerve which is seen close to the tip of the coccyx and supplies the sphincter ani externus ; (3) the perforating cutaneous branch of the second and third sacral nerves, which winds round the inferior margin of the glutæus maximus lateral to the perineal branch of the fourth sacral nerve ; (4) the perineal artery and (5) the perineal nerve dividing into superficial and deep divisions which are seen in the anterior part of the fossa.

In **Cleaning a Muscle** the dissector has to remove the sheath (epimysium) covering its surface. When the reddish fibres of the muscle are exposed by cutting the sheath with the scalpel at one place he should hold the cut edge of the sheath with forceps and carry the edge of the scalpel along the direction of the fibres of the muscle and not across them.

In **Cleaning a Vessel or Nerve** the dissector has to remove carefully the loose areolar tissue in which it is embedded.

The **Sphincter ani externus** (Fig. 1) arises from the tip of the coccyx, encircles the anal aperture and is inserted into the central tendinous point of the perineum : most of its superficial fibres are inserted into the integument. It is supplied by a branch from the fourth sacral nerve and by the inferior hæmorrhoidal nerve. *Action.*—Normally the fibres of the muscle are in a state of contraction and keep the anal aperture closed but they may be firmly contracted under the influence of the will.

The **Ischiorectal fossa** (Fig. 1) is the space between the anal canal and the ischium. It is a pyramidal cavity, the *base* of which is formed by the integument ; and the *apex*, directed towards the pelvis, is the meeting line of the obturator and anal fasciæ. It is **bounded** *medially* by the levator ani muscle covered by the anal fascia ; *laterally* by the obturator internus muscle covered by the obturator fascia ; *anteriorly* by the fascia of the urogenital diaphragm and the transversus perenei superficialis ; and *posteriorly* by the glutæus maximus and the sacrotuberous ligament. **Contents.**—The fossa is filled with fat. The arteries and nerves seen in the fossa are : the inferior hæmorrhoidal and perineal branches of the internal pudendal artery ; the inferior hæmorrhoidal and perineal branches of the pudendal nerve ; the perineal branch of the fourth sacral nerve and the perforating cutaneous branch from the second and third sacral nerves.

The *inferior hæmorrhoidal arteries* are two or three branches which perforate the medial wall of Alcock's canal and pass medialwards to supply the anal canal and the muscles and skin of the anal region and anastomose with the other hæmorrhoidal arteries. The *inferior hæmorrhoidal veins* open into the internal pudendal vein.

The *inferior hæmorrhoidal nerve* has the same course as the inferior hæmorrhoidal arteries. It supplies the external sphincter ani, the skin around the anus and communicates with the perineal nerve.

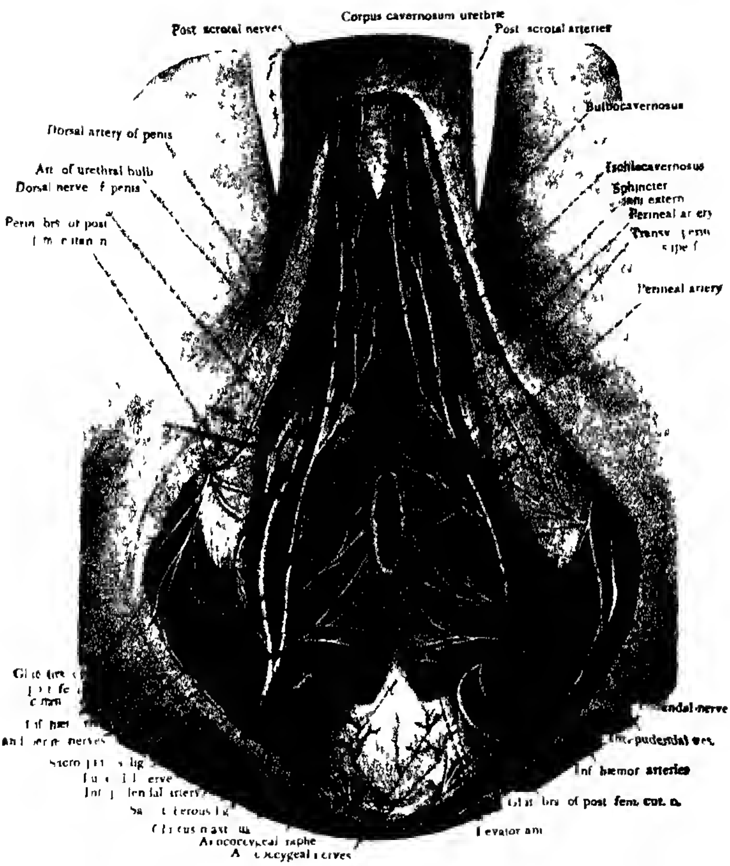


Fig. 1.—Dissection of the perineum (Sobotta)

To face P 4

The *perineal branch of the fourth sacral nerve* pierces the coccygeus near the coccyx and supplies the sphincter **ani** externus and the skin between the anus and the coccyx.

The *perforating cutaneous branch* of the second and third sacral nerves pierces the sacrotuberous ligament, winds round the lower margin of the glutæus maximus and supplies the skin of the lower part of the gluteal region.

Levator ani.—Its origin will be seen during the dissection of the pelvis. It is inserted into: (1) the side of the lower part of the coccyx; (2) a fibrous raphe (*anococcygeal raphe*) extending from the coccyx to the posterior margin of the anus; (3) the side of the anal canal; and (4) the central tendinous point of the perineum. In the female the anterior fibres of the levator ani pass to the side of the vagina. The muscle is supplied by a branch from the fourth sacral nerve and by a branch from the perineal nerve.

Between the anus and the tip of the coccyx a mass of muscular and fibrous tissue exists called the *anococcygeal body*.

Dissection. The student should now open up Alcock's canal on one side and study its contents. Pick up the inferior hæmorrhoidal vessels and nerve with forceps and pull them to make their points of exit from Alcock's canal prominent. An antero-posterior ridge will now be seen along the canal. Make an incision along this ridge and trace the internal pudendal vessels and pudendal nerve.

The *internal pudendal artery* (Fig. 1) lies in the lateral wall of the ischiorectal fossa in Alcock's canal which is formed by the obturator fascia. It is accompanied by two venæ comitantes and the pudendal nerve; in the canal it gives off the inferior hæmorrhoidal and perineal branches; it then passes forwards between the two layers of the fascia of the urogenital diaphragm.

The *pudendal nerve* (Fig. 1) lies in Alcock's canal where after giving off the inferior hæmorrhoidal branch, it divides into two terminal branches, the perineal nerve and the dorsal nerve of the penis.

The formation of Alcock's canal will be examined with the dissection of obturator fascia.

THE UROGENITAL TRIANGLE

Dissection. Enlarge the vertical median incision upwards as far as the root of the scrotum and reflect the skin on either side.

The **Superficial fascia** of this region is found to consist of two layers. The *superficial layer* is fatty and is merely a portion of the general superficial fascia. But nearer the scrotum the fat becomes scarcer and in the scrotum itself the fat is replaced by involuntary muscular fibres constituting what is known as the *tunica dartos.* On reflecting the fatty superficial layer to either side, the *deep layer* (*Fascia of Colles*) is exposed . It is an aponeurotic stratum of limited extent and is attached *laterally* to the external lip of the medial margins of the inferior rami of the ischium and os pubis ; *behind* it is blended with the base of the inferior layer of the urogenital diaphragm by turning round the transversus perinei superficiales. Traced *in front,* it is found to be continuous with the tunica dartos of the scrotum and with the deep fascia of the penis. Thence it can be shown to be continuous with the deep layer of the superficial fascia (fascia of Scarpa) of the anterior abdominal wall. A median septum ascends from the upper aspect of the fascia at its back part only. The attachments of the fascia of Colles are important, for they guide the course of urine extravasated beneath the superficial fascia in cases of rupture of the urethra. The urine cannot pass backwards into the ischio-rectal fossa, for there the fascia of Colles is blended with the base of the urogenital diaphragm around the transversus perinei superficiales ; nor can it pass into the inner side of the thighs owing to the attachment of the fascia to the inferior rami of the ischium and os pubis. The urine however is free to pass over the scrotum and penis to the anterior abdominal wall.

Dissection. The facts stated above can be verified thus :— Make a small puncture in the fascia of Colles on one side and introduce the narrow end of a blow pipe. Press the margins of the opening close around the pipe and inflate the space by forcing air into it. It will then be seen that the air introduced will first fill one side of the space, then pass forwards to the scrotum and eventually will fill the opposite side and, if the pressure is maintained, may force its way to the anterior abdominal wall. The course of air shows that the median septum though complete over the perineal space is deficient over the scrotum. Reflect the deep layer of the superficial fascia to either side and note its attachments to the ischio-pubic rami by introducing the handle of the scalpel underneath the fascia. Dissect the superficial perineal muscles, vessels and nerves (Fig. 1) which lie under its cover.

The *perineal artery* is a branch of the internal pudendal. It

passes forwards from its origin within Alcock's canal, crosses the transversus perinei superficialis muscle to gain the interval between the bulbo-cavernosus and the ischio-cavernosus and finally ends in several *posterior scrotal branches* to supply the scrotum. It also supplies the superficial perineal muscles. It gives off the *transverse perineal artery* which runs transversely along the surface of the transversus perineal muscle and anastomoses with its fellow of the opposite side.

The *posterior scrotal nerves* are two in number, medial and lateral. They are the branches of the superficial divisions of the perineal branch of the pudendal nerve. Piercing the inferior fascia of the urogenital diaphragm they pass forwards in company with the posterior scrotal vessels to end in the scrotum.

The *long perineal branch of the posterior femoral cutaneous nerve* (long pudendal nerve) pierces the fascia lata about an inch in front of the ischial tuberosity lateral to the margin of the pubic arch. It passes forwards and ends in the scrotum communicating with the posterior scrotal nerves.

The *perineal nerve* is the larger of the two terminal branches of the pudendal nerve. It runs in company with the perineal artery and divides into a superficial and a deep division at the front part of the ischiorectal fossa. The superficial division breaks into posterior scrotal and the deep division divides into muscular branches which supply the perineal muscles.

The **Transversus Perinei Superficialis** arises from the medial side of the inferior ramus of the ischium in front of the ischial tuberosity. It passes horizontally medialwards and is inserted into the central tendinous point of the perineum joining with the muscle of the opposite side and with the sphincter ani externus as also with the bulbo-cavernosus. *Action.*—It fixes the central tendinous point of the perineum.

The **Ischio-cavernosus** (Erector penis) covers the crus penis. It arises from the inner surface of the ischial tuberosity and ends in an aponeurosis which is inserted into the sides and under surface of the crus penis. *Action.*—It compresses the crus penis and retards the escape of blood from the corpus cavernosum penis, thus maintaining the erection of the penis.

The **Bulbo-cavernosus** (Ejaculator urinæ) covers the corpus cavernosum urethræ and is made up of two symmetrical halves. It arises from the central tendinous point of the perineum, and from the fibrous median raphe in front of it. Its fibres are directed lateralwards and constitute a thin muscle which has the

following insertion :—the posterior fibres into the inferior fascia of the urogenital diaphragm ; the middle fibres into an aponeurosis on the upper surface of the corpus cavernosum urethræ : and the anterior fibres into an aponeurosis on the dorsum of the penis. *Action.*—During the flow of urine in micturition, the fibres of the muscle are relaxed but they are called into use to empty the urethral canal at the end of the process. It also ejects the semen from the urethral canal.

Nerve-supply.—These three superficial perineal muscles are supplied by the perineal nerve.

The *central tendinous point of the perineum* means the tendinous point between the urethra and the anus formed by the meeting together of six muscles, viz., the two transversi perinei superficiales, the sphincter ani externus, the bulbo-cavernosus and the anterior fibres of the two levatores ani.

Dissection. Remove the superficial muscles, vessels and nerves. The *root of the penis* consisting of three structures, viz., the two crura and the bulb of the urethra, is now exposed. During the dissection of the penis it will be seen that the body of the penis consists of three portions: —the two corpora cavernosa penis situated superiorly and the corpus cavernosum urethræ situated inferiorly If the corpora cavernosa penis are traced backwards they are found to separate from one another near the lower margin of the symphysis pubis and become the *crura of the penis* which are attached to the inner side of the inferior rami of the ischium and os pubis, one on each side. The corpus cavernosum urethræ dilates into a bulbous termination, called the *bulb of the urethra*, which lies below the inferior fascia of the urogenital diaphragm, being intimately connected with it by an aponeurotic attachment. Cut through the crura of the penis and reflect them The urogenital diaphragm is now exposed.

The **Urogenital Diaphragm** (Deep perineal fascia) is a strong triangular membrane which stretches horizontally across the pubic arch and forms the partition wall between the pelvis and the anterior part of the perineum. It is attached on either side to the inner lip of the medial margins of the inferior rami of the ischium and os pubis. From its shape it was formerly termed the *triangular ligament.* It consists of two layers, a superior and an inferior, which are fused together posteriorly, but are separated from each other anteriorly. The inferior layer or *inferior fascia of the urogenital diaphragm* (superficial layer of the triangular ligament) is attached on either side to the inner lip of the medial

margins of the inferior rami of the ischium and os pubis. Its apex does not reach the pubic arcuate ligament but an oval interval is left which gives passage to the deep dorsal vein of the penis. Its base is turned towards the anus and is blended

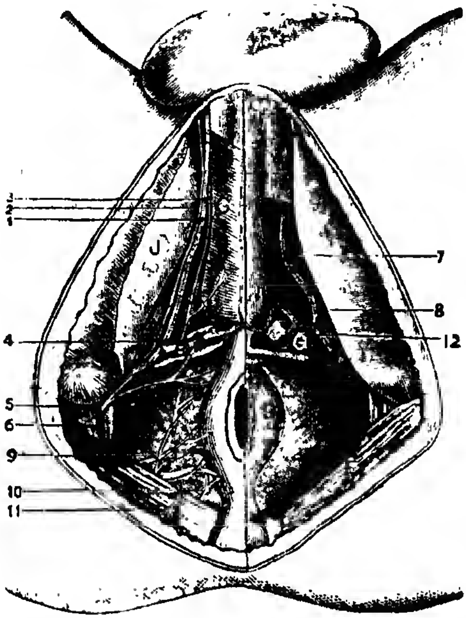


Fig. 2.—Dissection of the perineum. Some of the deep structures are seen on the left side. (Altered from Morris.)

A. Ischio-cavernosus.
B. Transversus perinei superficialis.
C. Bulbo-cavernosus.
D. External sphincter ani.
E. Levator ani.
F. Gluteus maximus.
G. Sphincter urethræ membranaceæ.
H. Crus penis.
I. Bulb of the urethra.
J. Deep layer of superficial perineal fascia.

1. Posterior scrotal branch of perineal artery.
2. Lateral posterior scrotal nerve.
3. Medial posterior scrotal nerve.
4. Transverse perineal artery.
5. Perineal nerve.
6. Internal pudendal artery.
7. Continuation of internal pudendal artery
8. Artery to the bulb.
9. Inferior hæmorrhoidal vessels and nerve.
10. Perineal branch of fourth sacral nerve.
11. Perforating cutaneous branch.
12. Bulbo-urethral gland.

with the superior layer and has been seen to be continuous with the fascia of Colles behind the transversus perinei superficialis. It is perforated by (1) the urethra in the middle line about an inch below the symphysis pubis, (2) the arteries

and nerves to the bulb, which are seen on either side of the urethral aperture, (3) the ducts of the bulbo-urethral glands close to the urethra, (4) the deep arteries of the penis, about midway between its apex and base, (5) the dorsal arteries and nerves of the penis, near the apex of the fascia, and (6) the perineal vessels and nerves at its base.

On detaching the inferior fascia from the ischio-pubic rami on one side and reflecting it towards the middle line, the *superior fascia of the urogenital diaphragm* and the structures lying between the two layers of the urogenital diaphragm are exposed. This superior layer is a continuation of the parietal layer of the pelvic fascia (obturator fascia) and is fused at its base and apex with the inferior layer. Between the two layers are seen (1) the membranous portion of the urethra, (2) the sphincter urethræ membranaceæ, (3) the transversus perinei profundus, (4) the bulbo-urethral glands, (5) the internal pudendal arteries with their branches to the urethral bulb and their terminal branches, and (6) the dorsal nerve of the penis (Fig. 2).

The *membranous portion of the urethra* is about three-fourths of an inch (2 cm.) long and is enclosed by the sphincter urethræ membranaceæ.

The **Sphincter Urethræ Membranaceæ** consists of two sets of fibres, an external and an internal; the former arises from the junction of the inferior rami of the ischium and os pubis and from the inferior fascia of the urogenital diaphragm and passes towards the membranous portion of the urethra; some fibres passing in front of, and some behind the urethra, they unite with the corresponding fibres of the opposite muscle. The internal set consists of circular fibres which enclose the membranous urethra. The muscle is supplied by the perineal nerve. *Action.*—It acts as a sphincter and ejects the contents of the membranous urethra.

The **Transversus Perinei Profundus** arises from the inferior ramus of the ischium and passes medialwards to blend with its fellow of the opposite side in a fibrous raphe. It is supplied by the perineal nerve. *Action.*—It acts as a tensor of the central tendinous point of the perineum.

The *bulbo-urethral glands* (*Cowper's glands*) are two small lobulated bodies resembling peas in size. They are found under cover of the sphincter urethræ membranaceæ one on either side of the middle line lateral to the membranous portion of the urethra. Their ducts open into the cavernous portion of the urethra about an inch in front of the urogenital diaphragm.

The *internal pudendal artery* has been seen to lie within Alcock's canal. It then passes between the two layers of the urogenital diaphragm. About half an inch below the symphysis pubis, it pierces the inferior layer of the urogenital diaphragm and divides into two branches, the *deep artery of the penis* and the *dorsal artery of the penis*. The former enters the crus penis, runs forwards and ramifies in the corpus cavernosum penis ; the latter runs upwards between the crus penis and symphysis pubis and, passing between the two layers of the suspensory ligament of the penis, reaches the dorsum of the penis. Before dividing into its terminal branches the internal pudendal artery gives off the *artery to the bulb*, which passes medialwards between the two layers of the urogenital diaphragm and supplies the bulbo-urethral gland, the bulb of the urethra and the corpus cavernosum urethræ.

The *dorsal nerve of the penis* accompanies the internal pudendal artery between the two layers of the urogenital diaphragm and, piercing its inferior layer half an inch below the symphysis pubis, supplies a filament to the corpus cavernosum penis and then continues its course with the dorsal artery of the penis.

Lymphatic Vessels of the Perineum.—To display these a special careful dissection is necessary . The lymphatic vessels of the skin, fasciæ and muscles of the perineum and of the skin of the scrotum and penis follow the course of the external pudendal vessels and terminate in the superficial inguinal and subinguinal lymph glands.

Lymph Glands are oval or rounded bodies of different colour varying from pink to black. They are seen along the lymphatic and lacteal vessels ; the lymph or chyle passes through them before it enters the blood. Each gland is provided with an *afferent* lymph vessel which enters the gland at some part of its periphery and with an *efferent* lymph vessel which emerges from a side of the gland.

Directions. When the student completes the dissection of the perineum, the part should be covered with tow soaked in preservative solution and the flaps of skin should be drawn over and stitched together.

THE FEMALE PERINEUM

The steps of the dissection and the parts seen in the **posterior** or **anal triangle** in the female are much the same as in the male.

THE ANTERIOR OR UROGENITAL TRIANGLE

The anterior triangle requires special study. The external genital organs peculiar to the female sex are :—(1) the mons pubis, (2) the labia majora, (3) the labia minora, (4) the clitoris, (5) the vestibule of the vagina, (6) the external orifice of the urethra, (7) the orifice of the vagina, and (8) the greater vestibular glands. The term *vulva* or *pudendum* is usually employed to include all these parts (Fig. 3).

The *mons pubis* (mons Veneris) is an eminence situated in front of the symphysis pubis formed by fatty tissue beneath the skin. It is covered with hair after puberty.

The *labia majora* are two prominent folds which commence from the mons pubis and proceed towards the anal aperture. They correspond to the scrotum in the male. The external surface of each labium is covered with hair while the internal surface is smooth and oily due to sebaceous glands pouring their secretion upon it. Anteriorly they unite to form the *anterior commissure* but posteriorly they do not join completely ; the connecting skin between them constitutes the *posterior commissure*. The elliptical fissure enclosed by the labia majora is known as the *urogenital fissure* which contains the orifices of the vagina and urethra.

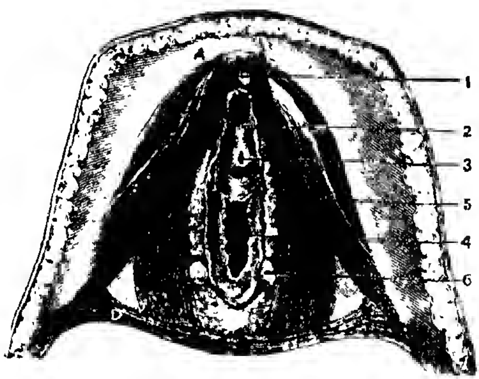


Fig. 3.—Dissection of the anterior or urogenital triangle in the female.

A. Pubis.
B. Ischio-cavernosus.
C. Bulbo-cavernosus.
D. Transversus perenei superficialis.

1. Clitoris.
2. Vestibule.
3. Urethral orifice.
4. Vagina.
5. Bulb of the vestibule.
6. Greater vestibular gland.

The *labia minora* or *nymphæ* are two small folds of integument situated under cover of the labia majora. They commence on each side of the clitoris and are lost in the labia majora and the vaginal wall. Anteriorly the nymphæ divide into an upper and a lower portion. The upper portion of one side unites above the clitoris with that of the opposite side and forms the *prepuce of the clitoris*. The lower portions of the two sides unite below the clitoris to form the *frenulum of the clitoris*. In females who have borne no children a muco-cutaneous fold stretches between the posterior ends of the labia minora: this is called the *frenulum of the labia* or *fourchette*. The depression between the fourchette and the vaginal entrance is called the *fossa navicularis*. The nymphæ correspond to the prepuce in the male.

The *clitoris* is a small projection connected to the pubic arch by the crura. It corresponds to the penis in the male and is situated below the anterior commissure. It consists of three portions; two crura, a body, and a glans.

The *vestibule of the vagina* is the triangular space between the clitoris in front and fourchette behind. In it are seen the orifices of the vagina, urethra and ducts of the greater vestibular glands.

The *external orifice of the urethra* is situated about an inch behind the clitoris just in front of the vaginal orifice.

The *orifice of the vagina* is the cleft lying below and behind the urethral opening. In the virgin it is imperfectly closed by a fold of mucous membrane called the *hymen*. When the hymen is ruptured three or four small elevations are left as its remains and are known as the *carunculæ hymenales*.

Dissection. Enlarge the vertical median incision of the anal triangle upwards encircling the urogenital fissure. The flaps of integument are to be reflected as in the male perineum.

Note. For the detailed description of the structures seen in the urogenital triangle in the female, the student should read the description of the corresponding structures in the male (p. 6 et seq). The modifications and special points are mentioned here.

The *superficial fascia* is divisible into two layers as in the male. The *superficial layer* is fatty and contains involuntary muscular fibres where it enters the labia majora. The *deep layer* has the same attachments and connections as in the male.

The *perineal artery* divides into the labial branches which terminate in the labia majora.

The *posterior labial nerves* are derived from the perineal nerve. These and the *long perineal branch of the posterior femoral cutaneous nerve* are distributed to the labia majora.

Dissection. Remove the perineal vessels and the posterior labial nerves.

The *transversus perinei superficialis* has the same attachments as in the male but is poorly developed.

The *ischio-cavernosus* (Erector clitoridis) has the same origin as in the male and is inserted into the crus of the clitoris.

The *bulbo-cavernosus* (Sphincter vaginæ) takes origin from the central tendinous point of the perineum behind, passes forwards encircling the orifice of the vagina lateral to the bulb of the vestibule and is inserted into the sides and dorsum of the clitoris.

Nerve-supply.—These three muscles are supplied by the perineal nerve.

Dissection. Remove the bulbo-cavernosus, ischio-cavernosus and the transversus perinei superficialis.

The *bulb of the vestibule* is now exposed. It corresponds to the bulb of the urethra in the male. It consists of two masses of erectile tissue placed one on either side of the vaginal orifice and the vestibule. They are broad behind but taper in front where they are united to each other by a plexus of veins, called the *pars intermedia*, lying between the clitoris and the urethra. They are covered laterally by the bulbo-cavernosus and medially by the mucous membrane of the vagina.

The *perineal body* is a collection of fibrous and muscular tissue, situated between the anterior wall of the anus and the posterior wall of the vagina. The muscular fibres are derived from the neighbouring muscles, viz., the external sphincter ani, the levatores ani and the bulbo-cavernosus. It serves the important purpose of allowing a good deal of stretching without tearing or laceration during parturition.

Clitoris.—The *crura of the clitoris* are erectile structures corresponding to the crura of the corpora cavernosa penis. Each crus is covered by the ischio-cavernosus and is attached to the inferior rami of the ischium and os pubis. The two crura converge in front of the symphysis pubis to form the *body of the clitoris*. The two halves of the body are the two corpora cavernosa and are separated from each other by an imperfect septum. The free extremity of the clitoris is called the *glans* and consists of erectile tissue.

Urogenital diaphragm.—Its connections resemble those in the male. It is less strong but broader than in the male. It is perforated in the middle line by the aperture of the vagina and in front of this it is perforated by the urethra. Its apex is separated from the arcuate pubic ligament by an aperture through which the deep dorsal vein of the clitoris passes; its base is blended with the fascia of Colles.

Dissection. Raise forwards the posterior end of the bulb of the vestibule and clean the greater vestibular glands with their ducts situated behind the bulb.

The *greater vestibular glands* (Glands of Bartholin) are two small rounded or oval bodies situated one on either side of the vaginal orifice behind the bulb of the vestibule. Their ducts open into the vagina just below the hymen or its remains.

Dissection. Reflect the inferior layer of the urogenital diaphragm on one side. Trace the dorsal artery, vein, and nerve of the clitoris; and clean the two perineal muscles seen.

The *transversus perinei profundus* arises from the inferior ramus of the ischium and passes medialwards to be inserted into the vaginal wall. It helps to fix the central tendinous point of the perineum. It is supplied by the perineal nerve.

The *sphincter urethræ membranaceæ* consists of an external and an internal set of fibres; the former arises from the junction of the ischium and os pubis and passes medialwards to unite with the corresponding fibres of the opposite muscle; the latter encloses the lower end of the urethra. It is a constrictor of the urethra. It is supplied by the perineal nerve.

The *female urethra* is about one inch and a half (4 cm.) long. It passes downwards and forwards from the apex of the bladder to the external urethral orifice and lies against the anterior wall of the vagina.

The *terminal part of the internal pudendal artery* corresponds to that in the male and gives off similar branches, viz., the *artery to the bulb* (of the vestibule), the *deep artery of the clitoris* and the *dorsal artery of the clitoris.*

The *pudendal nerve* after giving off its perineal branch is continued as the *dorsal nerve of the clitoris* to the dorsum of the clitoris and is accompanied by the dorsal artery of the clitoris. The *dorsal vein of the clitoris* occupies the groove in the middle line of the dorsum of the clitoris.

Note the *directions* at the end of the Male Perineum.

THE ANTEROLATERAL WALL OF THE ABDOMEN

The body is to be placed upon its back with blocks beneath the thorax and pelvis. Devote three days to the dissection of this region.

Surface Anatomy.—The following landmarks should be recognised before the skin is reflected :—the symphysis pubis, the pubic tubercle, the anterior superior iliac spine, the crest of the ilium, the xiphoid process and the costal arch. The groove seen in the middle line from the xiphoid process to the symphysis pubis is the depression between the two recti muscles and corresponds to a longitudinal fibrous structure underneath called the linea alba. A little below its centre is seen the umbilicus or navel. If the rectus muscle is well developed, a curved line is seen at its lateral margin corresponding to the *linea semilunaris*—the linea is the line of splitting of the aponeurosis of the internal oblique muscle. The inguinal furrow is seen as a curved linear depression which corresponds to the line of the inguinal ligament. The subcutaneous inguinal ring can be felt by invaginating the scrotum immediately above and to the lateral side of the pubic tubercle ; the abdominal inguinal ring is situated a finger's breadth above the middle of the inguinal ligament ; the position of the inguinal canal is ascertained by drawing a line joining the two points corresponding to the two rings. The spermatic cord should be felt and the ductus deferens lying at its back part can be easily recognised by its cord-like feel.

Dissection. The following *incisions* should be made : (1) a longitudinal incision from the xiphoid process to the symphysis pubis along the middle line of the body ; (2) from the symphysis pubis along the inguinal ligament to the crest of the ilium and along the crest as far backwards as practicable ; (3) from the xiphoid process a transverse incision around the chest as far back as possible ; (4) a transverse incision from the anterior superior iliac spine towards the middle line. Reflect the large skin flap lateralwards and the triangular flap of skin towards the thigh (Fig. 4). The superficial fascia is exposed. On the right side of the body, the triangular flap of skin should be left intact for the special dissection of the parts concerned in inguinal hernia.

The **Superficial Fascia** in the lower part of the abdomen below the level of the line drawn transversely medialwards from the anterior superior iliac spine is divisible into two layers, a superficial and a deep.

The *superficial layer* (*fascia of Camper*) is fatty and is continuous above with the superficial fascia covering the thorax. Traced downwards it is continuous with the similar layer in front of the thigh. Traced downwards and medialwards it passes over the spermatic cord into the scrotum, where it changes its fatty character and forms the tunica dartos.

The *deep layer* (*fascia of Scarpa*) is stronger and more mem-

1. Dissection of scalp.
2. of face.
3. of anterior triangle of neck.
4. of posterior triangle of neck.
5, 6. of pectoral region and axilla.
7. of arm.
8. of bend of elbow.
9. of forearm.
10. of palm of hand.
11. of anterior abdominal wall.
12. of inguinal hernia.
13. of femoral hernia and femoral triangle.
14. of adductor canal.
15. of front of lower part of thigh.
16. of front of leg.
17. of dorsum of foot.

Fig. 4.—Anterior view of the body showing the lines of incisions for reflecting the integument.

branous than the superficial layer. In the middle line it is attached to the lower part of the linea alba and to the symphysis pubis and is continued over the dorsum of the penis, constituting the *fundiform ligament*. In the inguinal region it is separable from the superficial layer by the superficial epigastric vessels and the inguinal lymphatic glands. Above it blends with the superficial layer. Below it blends with the fascia lata of the thigh just below the inguinal ligament. Below and medially it passes over the spermatic cord to the scrotum where it forms the dartos tunic, and then becomes continuous with the fascia of Colles in the perineum. These connections of the fascia of Scarpa are important as explaining the course taken by urine extravasated between the inferior fascia of the urogenital diaphragm and the fascia of Colles. The urine cannot pass down the thigh owing to the attachment of the fascia of Scarpa to the fascia lata. But it is free to pass upwards along the abdominal wall.

Dissection. Look for the anterior cutaneous nerves by dividing the superficial fascia close to the middle line and in well-injected bodies they are easily secured as they are accompanied by cutaneous arteries. Look for the lateral cutaneous nerves by dividing the superficial fascia along the posterior axillary line and note each nerve divides into two: the anterior branch is to be traced forwards and the posterior backwards. Reflect the divided superficial fascia forwards towards the middle line.

Cutaneous Nerves (Fig 5) —These are the anterior and lateral cutaneous branches of the lower five or six thoracic nerves and the cutaneous branches of the ilio-hypogastric and ilio-inguinal nerves. (1) The *anterior cutaneous branches of the lower five or six thoracic nerves* become cutaneous by piercing the sheath of the rectus near the middle line and then run laterally for a short distance. These cutaneous branches are found to pass in company with the cutaneous arteries. (2) The *anterior cutaneous branch of the ilio-hypogastric nerve* pierces the aponeurosis of the external oblique muscle about an inch above the subcutaneous inguinal ring and supplies the skin of the hypogastric region. (3) The terminal part of the *ilio-inguinal nerve* becomes cutaneous through the subcutaneous inguinal ring and supplies the skin of the scrotum and the upper and medial side of the thigh. (4) The *lateral cutaneous branches of the last six thoracic nerves* emerge between the digitations of the external oblique muscle and reaching the surface each divides into an anterior and a posterior branch except the lateral cutaneous branch of the last thoracic

nerve. The *anterior branches* furnish twigs to the obliquus externus abdominis and pass forwards towards the rectus abdominis. The *posterior branches* are small and pass backwards over the latissimus dorsi. (5) The *lateral cutaneous branch of*

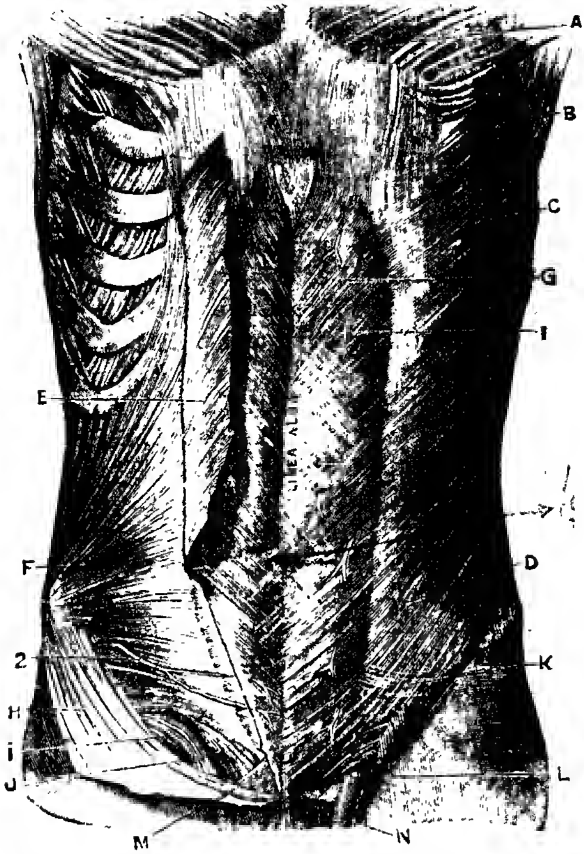


Fig. 5.—Superficial dissection of the anterolateral wall of the abdomen. (Cunningham.)

A. Pectoralis major.
B. Serratus anterior.
C. Obliquus externus abdominis.
D. Aponeurosis of external oblique muscle.
E. External oblique muscle (thrown forwards.)
F. Obliquus internus abdominis.
G. Sheath of rectus abdominis.
H. Aponeurosis of external oblique (reflected).
I. Cremaster.
J. Inguinal aponeurotic falx.
K. Intercrural fibres.
L. Subcutaneous inguinal ring.
M. Reflected inguinal ligament.
N. Spermatic cord.

1. Anterior cutaneous nerve.
2. Anterior cutaneous branch of ilio-hypogastric.

the twelfth thoracic nerve remains undivided and crosses the crest of the ilium about two inches behind the anterior superior iliac spine to supply the skin over the gluteal region. (6) The *lateral cutaneous branch of the ilio-hypogastric nerve* becomes cutaneous just above the crest of the ilium and crosses the crest behind the lateral cutaneous branch of the twelfth thoracic nerve. It supplies the skin over the gluteal region.

The **Cutaneous Arteries** accompany both the lateral and anterior cutaneous nerves. Those accompanying the anterior cutaneous nerves are the branches of the superior and inferior epigastric arteries. Those accompanying the lateral cutaneous nerves are the branches of the lower aortic intercostal arteries. In the groin three cutaneous branches ascend from the thigh and are branches of the femoral artery: (1) the *superficial external pudendal* which passes medialwards across the spermatic cord to supply the skin of the scrotum and penis; (2) the *superficial epigastric artery* which crosses the inguinal ligament about its middle and passes upwards towards the umbilicus; and (3) the *superficial circumflex iliac artery* which sends a few twigs to the skin near the anterior superior iliac spine.

Dissection. Remove the cutaneous vessels and nerves and also the superficial fascia. The obliquus externus abdominis is fully exposed which should be cleaned. In cleaning the sheath of the muscle carry the edge of the scalpel along the direction of the muscle fibres. In cleaning the aponeurosis of the muscle, be careful not to injure a thin membrane, the external spermatic fascia, which is connected with the margin of the subcutaneous inguinal ring.

The **Obliquus Externus Abdominis** (Figs. 5, 6) arises by eight fleshy digitations from the outer surfaces and lower borders of the lower eight ribs : of these the upper five interdigitate with the serratus anterior and the lower three with the latissimus dorsi. From these origins the fibres are directed to end in the following manner :—the posterior fibres descend almost vertically to be inserted into the anterior half of the outer lip of the iliac crest ; the upper and middle fibres of the external oblique muscle pass downwards and forwards and are inserted into an aponeurosis, called the aponeurosis of the external oblique.

The *aponeurosis of the external oblique* occupies the front of the abdominal wall medial to a line drawn from the prominence of the costal cartilage of the ninth rib to the anterior superior iliac spine. It passes medialwards in front of the rectus abdominis

and meets its fellow of the opposite side at the linea alba. Above it is continued over the thorax and gives origin to the pectoralis major. Below it forms a thickened band extending from the anterior superior iliac spine to the pubic tubercle and is known as the *inguinal ligament*. From the pubic tubercle some of the fibres are reflected to the pecten pubis forming the *lacunar ligament* and thence as a diverging triangular band called the *reflected inguinal ligament*. The portion of the aponeurosis lying between the upper and lower attachments occupies the front of the rectus muscle and contributes to the formation of its sheath. The aponeurosis is broad and strong inferiorly. A triangular opening, the *subcutaneous inguinal ring*, is seen in it immediately above the pubic crest.

The obliquus externus abdominis is supplied by the anterior divisions of the lower thoracic nerves. *Actions*.—When the thorax and pelvis are fixed and if both muscles act, they press the abdominal viscera and therefore help the rectum and bladder in expelling their contents. When the thorax is fixed, they will elevate the pelvis. If the pelvis is fixed, they will bend the trunk forwards. If the pelvis and vertebral column are fixed they will draw down the ribs helping expiration. If one muscle acts, it will turn the trunk to the same side.

Subcutaneous Inguinal Ring.—The aponeurosis of the external oblique is pierced just above the pubic crest by the spermatic cord in the male and the round ligament of the uterus in the female. The aperture formed in this manner is called the *subcutaneous inguinal ring* (External abdominal ring). From the margin of the opening a fascial prolongation is continued over the spermatic cord or the round ligament, called the *intercrural fascia* or the *external spermatic fascia*. Divide this fascia and note that the opening is triangular in shape with its base at the pubic crest and the apex directed upwards and lateralwards. The margins of the opening are called the *crura of the ring*. The *superior crus* (inner pillar) is thin and is attached to the front of the symphysis pubis. The *inferior crus* (outer pillar) is thick and is formed by the lower end of the inguinal ligament and upon it the spermatic cord rests. The ring measures from base to apex about an inch and across the base about half an inch. It is smaller in the female than in the male. Near the apex of the opening some arched fibres will be noticed passing from the lateral to the medial side. These are called the *intercrural fibres* and are continued downwards into the external spermatic fascia.

Dissection. Detach the digitations of the external oblique from the ribs. Then divide its attachment to the crest of the ilium. Next divide it transversely from the anterior superior iliac spine to the lateral border of the rectus and carry the incision downwards along the lateral edge of the rectus muscle to the pubis. Reflect the triangular piece of aponeurosis below the transverse incision downwards on the thigh. The parts concerned with the dissection of the inguinal hernia include this triangular aponeurosis and the structures situated beneath it. On the right side this triangular piece of aponeurosis is not to be disturbed and the student has already been advised to keep the corresponding triangular piece of skin intact. The remaining part of the external oblique and its aponeurosis should be thrown forwards as far as the lateral margin of the rectus.

The following parts of the aponeurosis of the external oblique should now be studied :--

(1) The *inguinal ligament* (*Poupart's ligament*) is the thickened lower margin of the aponeurosis of the external oblique muscle which is folded backwards and extends from the anterior superior iliac spine to the pubic tubercle It presents a grooved surface towards the abdomen ; in this groove are attached the internal oblique, the cremaster and the transversus abdominis. It is slightly curved with the convexity of the curve directed towards the thigh where the fascia lata is attached.

(2) The *lacunar ligament* (*Gimbernat's ligament*) is that part of the aponeurosis of the external oblique which is reflected from the pubic tubercle backwards and lateralwards for about an inch into the pecten pubis On raising the medial end of the inguinal ligament it is found to be triangular in shape with its apex at the pubic tubercle ; its base is concave and forms the medial boundary of the femoral ring. Its anterior border is continuous with the medial end of the inguinal ligament and its posterior border is attached to the pecten pubis.

(3) The *reflected inguinal ligament* (*Triangular fascia of the abdomen*) is a triangular aponeurosis which extends from the lacunar ligament to the linea alba. It passes upwards and medialwards behind the spermatic cord and the superior crus of the subcutaneous inguinal ring to be continuous with the ligament of the opposite side at the linea alba.

Dissection. Clean the surface of the internal oblique muscle taking care of the nerves which pierce it. These are : the ilio-inguinal nerve seen above the inguinal ligament ; the anterior

branch of the iliohypogastric seen near the anterior superior iliac spine, and the lateral cutaneous branches of the iliohypogastric and last thoracic nerves seen near the crest of the ilium. Define also the *cremaster muscle* : this consists of muscular loops which spring from the lower margin of the internal oblique and are prolonged down upon the spermatic cord.

The **Obliquus Internus Abdominis** (Figs. 6, 7) takes origin (1) from the lateral half of the grooved surface of the inguinal ligament ; (2) from the anterior two-thirds of the intermediate lip of the iliac crest ; and (3) from the lumbodorsal fascia. From this origin the fibres diverge in the following manner :—the fibres from the inguinal ligament which constitute the lowest fibres, pass downwards and medialwards in front of the spermatic cord or round ligament and become blended with those of the transversus abdominis forming the inguinal aponeurotic falx, which is inserted into the crest of the os pubis and into the pecten pubis. The fibres from the anterior third of the iliac crest pass horizontally medialwards to end at the lateral edge of the rectus in an aponeurosis which is inserted into the linea alba. The fibres from the middle third of the iliac crest pass upwards and medialwards and end in an aponeurosis which divides into two layers at the lateral border of the rectus—the anterior layer is inserted to the linea alba and the posterior layer to the cartilages of the seventh, eighth and ninth ribs ; the posterior fibres pass vertically upwards and are inserted into the lower borders of the cartilages of the lower three ribs where they are continuous with the internal intercostal muscles of the lowest two spaces.

The *aponeurosis of the internal oblique muscle* should now be traced. At the lateral edge of the rectus muscle it will be found to split in the upper three-fourths of its extent into two layers, an anterior and a posterior. The anterior layer passes in front of the rectus and blends with the aponeurosis of the external oblique. The posterior layer passes behind the rectus and blends with the aponeurosis of the transversus abdominis lying underneath. In the lower fourth of its extent the aponeurosis does not split but passes entirely in front of the rectus blending with the aponeurosis of the external oblique.

The obliquus internus abdominis is supplied by the anterior divisions of the lower thoracic nerves and by the iliohypogastric nerve. The *actions* of this muscle are like those of the external oblique in transmitting pressure over the abdominal viscera.

If one muscle acts it bends the lumbar part of the vertebral column to its own side. It is also a muscle of expiration.

The **Cremaster** is a muscular layer spread over the spermatic cord. It arises from the middle portion of the grooved surface of the inguinal ligament and from the inferior margin of the internal oblique muscle. It descends on the front and lateral aspects of the spermatic cord forming muscular loops. When the scrotum is dissected some of these loops will be found to descend as low as the tunica vaginalis testis where they are inserted. Others ascend along the medial aspect of the cord to be inserted into the pubic tubercle, into the pubic crest, and into the front of the sheath of the rectus. The muscular loops on the spermatic cord are bound together by areolar tissue forming a thin fascia called the *cremasteric fascia*. The cremaster is supplied by the external spermatic branch of the genito-femoral nerve which will be seen entering the deep surface of the muscle when it is reflected. *Action*.—It is an involuntary muscle which elevates the testis.

Dissection. Reflect the whole of the internal oblique muscle forwards towards the lateral edge of the rectus—but on the right side of the body keep intact the lower portion of the muscle viz., the portion corresponding to the triangular piece of aponeurosis of the external oblique which is concerned with the dissection of inguinal hernia. Make a vertical incision from the tip of the last rib to the iliac crest and extend it upwards along the costal arch Next cut through the muscle where it is attached to the iliac crest and the inguinal ligament. But on the right side after severing the muscle from the iliac crest the cut is to be continued horizontally from the anterior superior iliac spine to the margin of the rectus. An ascending branch of the deep circumflex iliac artery runs between the internal oblique and the transversus abdominis near the anterior part of the iliac crest and serves as a guide for separating the two muscles from each other. On the left side of the body divide the cremaster by a longitudinal incision over the spermatic cord and reflect it from the cord. While reflecting the internal oblique muscle forwards note the nerves and blood vessels entering the deep surface of the muscle. The transversus abdominis and the nerves of the anterolateral wall of the abdomen are now to be studied.

Nerves of the Anterolateral Wall of the Abdomen.—The *anterior divisions of the lower six thoracic nerves* enter the abdominal wall from the intercostal spaces and pass forwards between the

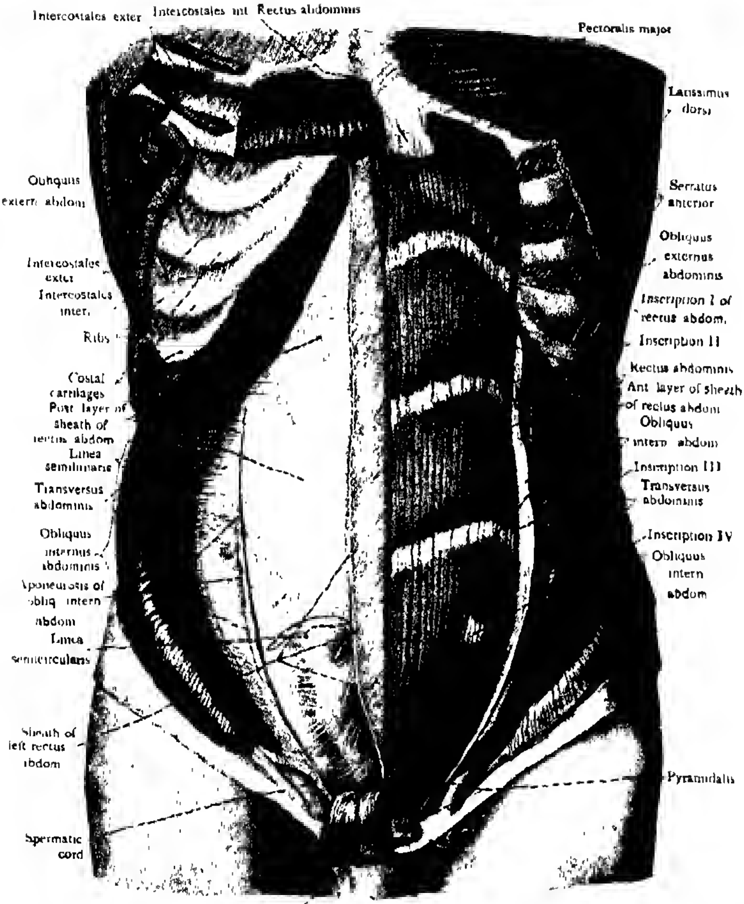


Fig. 6 —Muscles of the antero-lateral wall of the abdomen (Sobotta).

To face P. 24

internal oblique and the transversus muscles. They then enter the sheath of the rectus by piercing its posterior wall, supply the rectus and become the anterior cutaneous nerves by piercing the anterior wall of the sheath. During their course they supply branches to the internal oblique, the transversus abdominis and the rectus, and about midway between the spine and the linea alba, give off the lateral cutaneous nerves (p. 19). The *anterior division of the twelfth thoracic nerve* runs along the lower margin of the twelfth rib and is therefore not in an intercostal space. It has a similar course and distribution as the preceding nerves and supplies, in addition, the pyramidalis,. The *ilio-hypogastric nerve* pierces the posterior part of the transversus muscle a little above the crest of the ilium. It then passes forwards between the internal oblique and the transversus and divides into an iliac or lateral cutaneous branch and an anterior cutaneous branch. The *lateral cutaneous branch* pierces the internal and external oblique muscles and crosses the iliac crest for distribution in the gluteal region. The *anterior cutaneous branch* passes between the internal oblique and the transversus, and after supplying branches to them pierces the former muscle in front of the anterior superior iliac spine. It then pierces the aponeurosis of the external oblique about an inch above the subcutaneous inguinal ring (p. 19). The *ilio-inguinal nerve* pierces the transversus abdominis near the anterior part of the iliac crest and passes between the internal oblique and the transversus abdominis, supplying both the muscles. It then pierces the internal oblique and passes through the subcutaneous inguinal ring to become cutaneous.

The **Transversus Abdominis** (Transversalis) (Figs. 6, 7) forms the third stratum of the flat muscles of the abdominal wall. It arises from (1) the lateral third of the inguinal ligament, (2) the anterior two-thirds of the inner lip of the iliac crest, (3) the lumbo-dorsal fascia and (4) the inner surfaces of the cartilages of the lower six ribs interdigitating with the origin of the diaphragm. The lumbodorsal fascia is regarded as the posterior aponeurosis of the muscle. Anteriorly the muscle ends in a broad aponeurosis, which may be termed the anterior aponeurosis, and becomes inserted by means of this aponeurosis into the linea alba; the lowest portion of the aponeurosis becomes blended with that of the internal oblique and forms inguinal falx which is inserted into the pubic crest and the pecten pubis. The direction of the fibres of the muscle is mostly transverse but the lower fibres are directed in a curved manner and thus

the inferior margin of the muscle presents an arched appearance. It is supplied by the lower six thoracic nerves, the ilio-hypogastric and the ilio-inguinal nerves. *Action.*—The two transversi muscles compress the abdominal viscera. They are also muscles of expiration like the oblique muscles.

It should be noticed that the lower fibres of the aponeurosis of the transversus abdominis pass downwards and medialwards and blend with those of the internal oblique forming the inguinal falx. The rest of the aponeurosis passes forwards to be inserted into the linea alba ; its upper three-fourths pass behind the rectus and blend with the posterior layer of the aponeurosis of the internal oblique ; its lower fourth passes in front of the rectus.

The *inguinal aponeurotic falx* (Conjoined tendon) is the common aponeurotic insertion of the lower fibres of the aponeuroses of the internal oblique and the transversus abdominis. The transversus abdominis contributes to the formation of the greater part of the falx.

Dissection. Divide the anterior wall of the sheath of the rectus by a vertical incision and reflect the flaps on either side by dividing the adhesions between the sheath and the three or four tendinous intersections in the muscle. Note also a small muscle, the pyramidalis, near the pubis. Finally look for the terminations of the lower six thoracic nerves and the branches of the superior and inferior epigastric arteries under cover of the rectus abdominis.

The **Rectus Abdominis** (Fig. 6) extends along the whole length of the front of the abdominal wall and is separated from the corresponding muscle of the opposite side by the linea alba. It arises below by two tendons : the ~~medial~~ Lateral head, from the crest of the pubis ; the ~~lateral~~ Medial head from the ligaments in front of the symphysis pubis, in common with that of the opposite side. It is inserted by three slips into the anterior surfaces of the cartilages of the fifth, sixth and seventh ribs and by a small slip to the xiphoid process. The muscle is broad above but narrow below and consists of vertical fibres which are interrupted usually in three situations by tendinous intersections, called the *inscriptiones tendineæ.* These inscriptions have a zig-zag course and run transversely ; one is situated opposite the umbilicus ; the second is opposite the xiphoid process ; and the third midway between these two. A fourth one, when present, is seen below the umbilicus. They are firmly adherent to the anterior wall of the sheath of the rectus but are not attached to

its posterior wall. The rectus abdominis is supplied by the anterior divisions of the lower six thoracic nerves. *Action.*—It compresses the abdominal viscera. It depresses the thorax and is thus a muscle of expiration. It also flexes the vertebral column.

The **Pyramidalis** is a small triangular muscle which lies in front of the lower part of the rectus. It arises by its base from the front of the os pubis and from the ligaments in front of the symphysis pubis, and is inserted by its apex into the linea alba. This muscle is sometimes absent. The twelfth thoracic nerve enters the deep surface of the muscle and supplies it. *Action.*—It is a tensor of the linea alba. ([illegible])

The **Sheath of the Rectus** (Fig. 6) is formed by the aponeuroses of the two oblique muscles and the transversus abdominis. It consists of two walls, an anterior and a posterior. The *anterior wall* is formed throughout its entire extent by the aponeurosis of the external oblique which is strengthened in addition over the upper three-fourths of the rectus by the anterior layer of the aponeurosis of the internal oblique. Over the lower fourth of the rectus the aponeurosis of the external oblique is strengthened by fusion with the undivided aponeurosis of the internal oblique and the aponeurosis of the transversus. The *posterior wall* of the sheath is deficient above where the muscle rests on the xiphoid process and the cartilages of the fifth, sixth and seventh ribs. It is also deficient below behind the lower fourth of the rectus where the undivided aponeurosis of the internal oblique together with the aponeurosis of the transversus abdominis passes in front of the muscle. In the intermediate portion the posterior wall is formed by the blending of the posterior layer of the aponeurosis of the internal oblique and the aponeurosis of the transversus abdominis. Below, the posterior wall ends in a free crescentic margin with its concavity directed downwards, which is called the *linea semicircularis* (Semilunar fold of Douglas). Inside the sheath of the rectus are seen the rectus abdominis, the pyramidalis the terminations of the anterior divisions of the lower six thoracic nerves, and the superior and inferior epigastric arteries with some of their branches.

The **Linea Alba** is a fibrous raphe seen in the middle of the anterior abdominal wall, and attached above to the tip of the xiphoid process and below to the symphysis pubis. It is placed between the recti and is formed by the blending of the aponeuroses of the two oblique and the transverse muscles of opposite sides. It

is broader above than below ; its width corresponds to the interval between the two recti. Several small apertures can be seen in it for the passage of vessels and nerves. The largest aperture is at the site of the umbilicus and is closed after birth.

Dissection. Reflect the transversus abdominis by detaching it from the inguinal ligament and the iliac crest. Detach the muscle from the lumbo-dorsal fascia by a vertical incision and carry the incision upwards obliquely along the costal arch. The whole muscle can then be reflected forwards. The fascia transversalis is exposed.

Fig. 7.—Muscles of the anterolateral wall of the abdomen. The inguinal canal has also been laid open.

A. External oblique (reflected).
B. Internal oblique (cut).
C. Transversus abdominis.
D. Rectus abdominis.
E. Inguinal aponeurotic falx.
F. Fascia transversalis.
G. Infundibuliform fascia.
H. Cremaster.
I. Spermatic cord.

The **Fascia Transversalis** is a thin fibrous layer which lies between the transversus abdominis and the extra-peritoneal fat. *Above* it is thin and blends with the fascia covering the under surface of the diaphragm. *Below,* its attachments are : it is attached to the inner lip of the iliac crest ; from the anterior

superior iliac spine to the femoral vessels it is attached to the posterior aspect of the inguinal ligament and is there continuous with the fascia iliaca; in front of the femoral vessels it is prolonged into the thigh as the anterior layer of the femoral sheath; medial to the femoral vessels it is attached to the pecten pubis behind the attachment of the inguinal falx. *In front* it is continuous with the fascia of the opposite side. *Behind* it is lost in the fat covering the posterior surface of the kidney. Below the lower margin of the transversus abdominis the fascia is thick and is pierced by the spermatic cord in the male and the round ligament in the female. This opening in the fascia transversalis is called the **abdominal inguinal ring** (internal abdominal ring). It is situated midway between the anterior superior iliac spine and symphysis pubis and about half an inch above the inguinal ligament. It should be noted that the ring is not an open aperture in as much as a fascial prolongation is continued over the spermatic cord or the round ligament from the margin of the ring. This prolongation, called the *infundibuliform fascia,* is funnel-shaped and can be rendered tense and prominent by pulling the cord.

The **Inguinal Canal** is an oblique canal about an inch and a half (4 cm.) in length and gives passage to the spermatic cord in the male and the round ligament in the female. It begins above at the abdominal inguinal ring which is the inlet to the canal and ends below at the subcutaneous inguinal ring which is the outlet of the canal. It is directed obliquely downwards and medialwards being placed above and nearly parallel to the medial half of the inguinal ligament. Its *anterior wall* is formed by (1) the skin, (2) the superficial fascia, (3) the aponeurosis of the external oblique which covers the whole extent of the canal and (4) the internal oblique which covers the upper third of the canal only. Its *posterior wall* is formed by (1) the reflected inguinal ligament, (2) the inguinal aponeurotic falx, (3) the fascia transversalis, (4) the extraperitoneal fatty tissue, and (5) the peritoneum.

ANATOMY OF THE PARTS CONCERNED IN INGUINAL HERNIA

The student has already been advised to make the special dissection of the parts concerned in inguinal hernia on the right side of the body.

Dissection. The following incisions demarcate the triangular

flap of skin at the lower part of the abdominal wall. (1) A transverse incision from the anterior superior iliac spine to the middle line of the body. (2) A vertical incision from the termination of the first incision along the linea alba to the symphysis pubis (Fig. 4). Reflect the triangular flap of skin towards the thigh as also the corresponding superficial fascia in two layers beneath it. In reflecting the aponeurosis of the external oblique muscle carry the transverse incision from the anterior superior iliac spine to the lateral edge of the rectus abdominis and thence carry the incision vertically downwards along the lateral edge of the same muscle. Reflect the triangular piece of the aponeurosis towards the thigh. The subcutaneous inguinal ring and the structures connected with it are to be preserved. Divide the internal oblique at its origin from the inguinal ligament. The ascending branch of the deep circumflex iliac artery will serve as a guide for the depth of the incision. Reflect the internal oblique medialwards. Divide the cremaster on the surface of the spermatic cord and reflect it from the cord. The spermatic cord covered by the infundibuliform fascia, which is prolonged from the margin of the abdominal inguinal ring, is now exposed. Pull the spermatic cord and divide the infundibuliform fascia around it by a circular incision at the position of the abdominal inguinal ring. The margins of the ring are thus artificially defined. The extra peritoneal fatty tissue lying beneath the fascia transversalis and separating it from the peritoneum is now seen through the abdominal inguinal ring. Observe the inferior epigastric artery shining through the fascia transversalis. Its relation to the abdominal inguinal ring is important as it lies below and medial to the ring and passes obliquely upwards and medialwards towards the sheath of the rectus abdominis.

The inguinal canal and its boundaries have been described (p. 28).

VESSELS OF THE ABDOMINAL WALL

The arteries of the abdominal wall should now be studied.

The *lower two intercostal arteries* run through the tenth and eleventh intercostal spaces and pass forwards between the internal oblique and the transversus abdominis. They run in company with the corresponding nerves and anastomose with the superior and inferior epigastric arteries.

The *subcostal artery* runs along the lower border of the last

rib and accompanies the last thoracic nerve. Piercing the posterior aponeurosis of the transversus it runs forward between this muscle and the internal oblique and anastomoses with the last intercostal, first lumbar and superior epigastric arteries.

The *lumbar arteries*, usually four in number, continue their course in the abdominal wall by running forwards between the internal oblique and the transversus and anastomose with the intercostal arteries, the deep circumflex iliac artery and the inferior epigastric artery.

Inferior epigastric artery (Deep epigastric artery).—Its terminal part has been seen inside the sheath of the rectus while the remaining portion will be revealed on dividing the fascia transversalis which covers it. It arises from the external iliac artery about one-fourth of an inch above the inguinal ligament. At first it passes medialwards, then upwards and medialwards along the medial side of the abdominal inguinal ring lying between the peritoneum and the fascia transversalis. Then it pierces the fascia transversalis, passes in front of the linea semicircularis to the interior of the sheath of the rectus. Inside the sheath, the artery ascends behind the rectus, supplies branches to it and anastomoses with the superior epigastric artery. As the artery passes to the rectus muscle it forms the boundary of a triangular space called the recto-epigastric or *Hesselbach's triangle*; the other two sides of the triangle being formed by the lateral edge of the rectus and the inguinal ligament. The *branches* given off from the inferior epigastric artery are :—(1) the *external spermatic artery* (cremasteric artery) which supplies the cremaster muscle by entering its deep surface ; (2) the *pubic artery* which passes medialwards to the back part of the pubis and anastomoses with the pubic branch of the obturator artery ; (3) the *muscular branches* which supply the rectus by entering its deep surface ; (4) the *cutaneous branches* which pierce the rectus and the anterior wall of its sheath to supply the skin.

The *deep circumflex iliac artery* arises from the external iliac artery opposite the origin of the inferior epigastric artery. It passes upwards and lateralwards behind the inguinal ligament between the peritoneum and the fascia transversalis. At the anterior superior iliac spine it pierces the fascia transversalis and passes backwards between it and the transversus along the iliac crest to its middle. It then pierces the transversus and terminates between it and the internal oblique. Near the anterior superior iliac spine it gives off an *ascending branch*, which

pierces the fascia transversalis and the transversus abdominis and then ascends between the latter and the internal oblique.

The *superior epigastric artery* is one of the terminal branches of the internal mammary artery. Near the posterior aspect of the seventh costal cartilage it enters the sheath of the rectus, supplies the muscle and anastomoses with the inferior epigastric artery.

Dissection. Reflect the fascia transversalis by detaching it from the inguinal ligament and the iliac crest. Make a longitudinal incision on the infundibuliform fascia covering the spermatic cord and reflect the fascia on either side.

The *extra-peritoneal fatty tissue* which intervenes between the fascia transversalis and the peritoneum is now exposed. It is scanty on the antero-lateral wall of the abdomen and is found to be prolonged over the spermatic cord beneath the infundibuliform fascia.

SCROTUM, SPERMATIC CORD, TESTIS AND PENIS

The dissection of the scrotum and the penis should be taken up next as they soon become too dry.

The **Scrotum** is a cutaneous pouch containing the testes and the lower portions of the spermatic cords. The skin is of a dark colour and divided into two halves by a median *raphe* which is continued forwards to the under surface of the penis and also backwards along the middle line of the perineum to the anus.

Dissection. Hook down the testis and reflect the skin by making a vertical incision from the region of the subcutaneous inguinal ring to the lower end of the scrotum. The superficial fascia consisting of two layers (which have become united into one layer in the scrotum) and containing nonstriped muscle-fibres is now exposed. It is called the *dartos tunic*. These two layers of superficial fascia are continuous with the similar layers found in the groin and the perineum. The dartos gives off a septum which divides the scrotal pouch into two cavities, one for each testis. It should be noticed that the testis and the spermatic cord within the scrotum are covered by (1) the external spermatic fascia, (2) the cremasteric fascia, and (3) the infundibuliform fascia. Reflect the external spermatic fascia by a longitudinal incision and note that it is continuous with the margin of the subcutaneous inguinal ring. Divide the cremasteric fascia by a similar incision and trace its continuity through the subcutaneous

inguinal ring with the cremaster muscle in the inguinal region. Reflect the infundibuliform fascia. Its continuity with the fascia transversalis at the margin of the abdominal inguinal ring has been already noted. Beneath this prolongation of the infundibuliform fascia is a layer of connective tissue continuous with the extra-peritoneal fatty tissue. Next display the constituent parts of the spermatic cord; separate them from one another by removing the areolar tissue and define the ductus deferens.

The **Spermatic Cord** (Fig. 10) extends from the abdominal inguinal ring to the posterior border of the testis. It lies obliquely in the inguinal canal, after its exit from which it descends vertically to the testis. Its coverings are derived from the strata in the abdominal wall and are prolonged into the wall of the scrotum. Its constituent parts are (1) the ductus deferens, (2) the testicular artery, (3) the artery to the ductus deferens, (4) the external spermatic artery, (5) the testicular veins, (6) the external spermatic nerve, (7) sympathetic nerve filaments and (8) lymphatic vessels. These structures are connected together by loose areolar tissue.

The *ductus deferens* (vas deferens) is the excretory duct of the testis. It begins at the lower end of the testis and ascends behind the other constituents of the cord to the abdominal inguinal ring, where it winds round the inferior epigastric artery and passes into the pelvis. It can be readily recognised by its hard cord-like feel. The *testicular artery* (spermatic artery) is a branch of the abdominal aorta. It issues out of the abdominal cavity through the abdominal inguinal ring, passes through the inguinal canal in company with the other constituents of the spermatic cord and proceeds to the testis and epididymis which it supplies. The *artery to the ductus deferens* is a small artery which issues from the superior vesical branch of the hypogastric artery. It passes along the surface of the ductus deferens. The *external spermatic artery* is a branch of the inferior epigastric artery. It supplies the cremaster and the coverings of the spermatic cord. The testicular veins issue from the back part of the testis. As they pass up the cord they form a plexus, called the *pampiniform plexus*. From it two veins emerge and pass up the inguinal canal, which finally unite to form a single vein. This vein will be seen during the dissection of the abdominal cavity to open into the inferior vena cava on the right side and into the renal vein on the left side. The *external spermatic nerve*

is a branch of the genito-femoral nerve. It has been seen to enter the deep surface of the cremaster. The *sympathetic nerve filaments* accompany the testicular artery. The *lymphatic vessels* accompany the testicular veins and drain into the lateral aortic and preaortic groups of lumbar lymph glands.

Dissection. Divide the spermatic cord at the subcutaneous inguinal ring and remove the cord with half of the scrotum and the enclosed testis for further examination. It is better to conduct this dissection under water after the cord and testis are

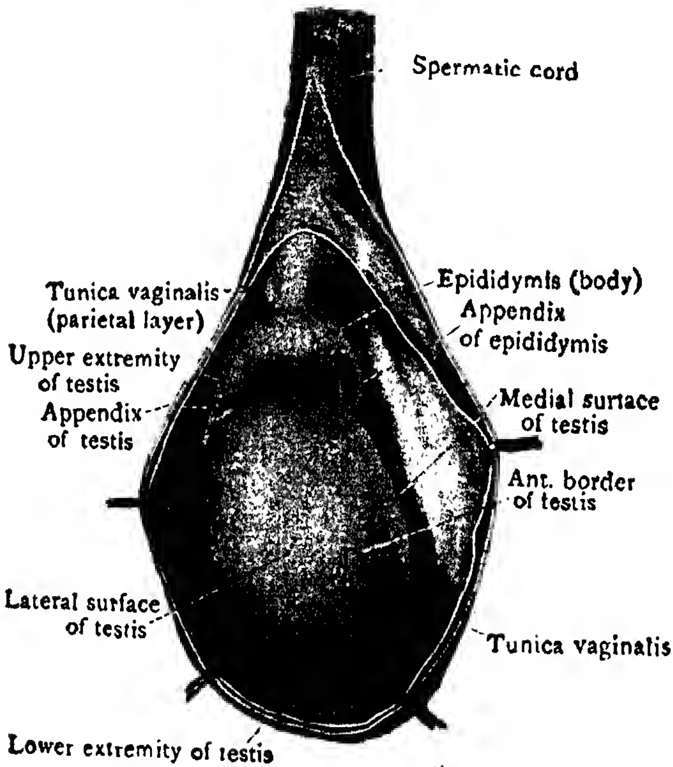
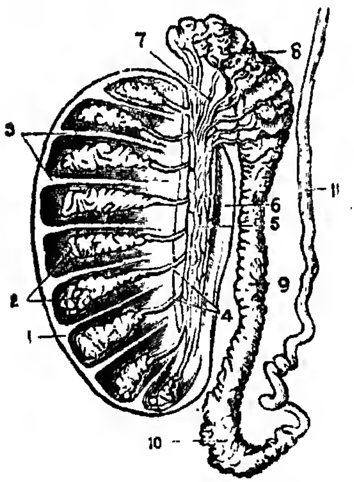


Fig 8.—The testis and epididymis. The tunica vaginalis has been laid open. (Sobotta).

fixed with pins on a piece of wood. The whole specimen should be placed in a tray filled with water. The coverings of the cord which have been divided by longitudinal incisions are to be fixed with pins as they are reflected on either side. Examine

the extent of the sac of the tunica vaginalis by making a small aperture into its anterior part and then inflating the sac. Lastly open the whole cavity of the tunica by a longitudinal incision over its anterior aspect.

The **Testis** (Fig. 8) is a glandular body which developed primarily in the abdominal cavity but descended into the scrotum before birth. In its descent it carries with it a process of peritoneum lining the abdominal cavity, called the *processus vaginalis*; this remains as a shut sac covering the surface of the testis and reflected on to the scrotum, and is called the *tunica vaginalis testis*, but the upper portion, from the abdominal inguinal ring to near the testis, becomes obliterated and forms a fibrous cord. The tunica vaginalis consists of a parietal and a visceral portion. The *parietal portion* is loose, lines the scrotum, and is carried over the spermatic cord for about half an inch. It is continuous with the visceral layer along the posterior border of the testis. The *visceral portion* covers the body of the testis except at its posterior border. It also lines the surfaces of the epididymis which lies on the lateral side of the testis. A pouch of the visceral layer



1. Tunica albuginea.
2. Lobules of the testis.
3. Septa between the lobules.
4. Vasa recta.
5. Rete testis.
6. Mediastinum testis.
7. Ductuli efferentes.
8. Head of epididymis.
9. Body of epididymis.
10. Tail of epididymis.
11. Ductus deferens.

Fig. 9.—Vertical section of the testis.

is seen between the body of the testis and the epididymis, called the *sinus of the epididymis* (digital fossa). Ordinarily there is little fluid in the sac of the tunica vaginalis but if fluid accumulates the condition is called hydrocele. Each testis is an oval body presenting two surfaces, two borders and two extremities. Its surfaces are medial and lateral and are more or less flattened.

Its anterior border is convex. Its posterior border is flat and to it is attached the spermatic cord. The epididymis lies on the upper end and on the lateral part of the posterior border of the testis. The upper end of the testis in the living subject is inclined a little forwards and presents anteriorly a minute body called the *appendix of the testis* (hydatid of Morgagni) ; it is sessile and represents the remains of the Mullerian duct found in the fœtus. The lower end of the testis is inclined a little backwards and descends slightly lower on the left side than on the right.

The **Epididymis** (Fig. 8) extends in the form of an arch and is attached to the upper end and lateral part of the posterior border of the testis. It consists of three parts: (1) the *head* or *caput epididymis* (globus major), which is the upper enlarged portion lying over the upper end of the testis and is connected with it by efferent ducts called the *ductuli efferentes* ; (2) the *body of the epididymis*, which is free and is separated from the body of the testis by a pouch of the tunica called the *sinus epididymis* ; (3) the *tail of the epididymis* (globus minor), which is its lower end and is attached to the posterior border of the testis by areolar tissue. The epididymis terminates in the ductus deferens which passes upwards along the posterior border of the testis medial to the body and head of the epididymis. A minute pedunculated body is sometimes seen attached to the head of the epididymis. It is called the appendix of the epididymis and represents the remains of a detached efferent duct.

Dissection. Observe the branches of the testicular vessels entering into and issuing from the posterior border of the testis. Peel off the visceral layer of the tunica vaginalis from the testis. Another fibrous covering is now seen underneath. This is the *tunica albuginea*. Within the tunica albuginea and lining the septa a thin vascular layer, thinner than the piamater of the brain, is seen ; in it the blood-ves els ramify prior to their distribution to the secreting tubes. Divide one testis into two halves by a longitudinal incision through the anterior and posterior borders and reflect the tunic backwards towards the posterior border of the testis. Here the tunica albuginea sends forwards a vertical septum called the *mediastinum testis* (corpus Highmori). Divide the other testis with its tunics transversely at about its middle. The dense white tunica albuginea with mediastinum testis projecting forwards from the posterior border of the testis will be seen. By gently squeezing out the

glandular substance many septa will be found passing from all sides of the mediastinum testis and dividing the glandular mass into a number of lobules. Inside these lobules the glandular mass under water can be drawn out by pins into fine thread like structures called *tubuli seminiferi contorti.* These tubules after a convoluted course in each lobule pass towards the mediastinum testis and jon with each other to form about twenty or thirty straight tubules called the *tubuli recti.* These tubuli recti enter the mediastinum testis and form a network of anastomosing tubes called the *rete testis.* These again end in about twelve to twenty ducts called the *ductuli efferentes* which become convoluted and form conical masses called the *lobules of the epididymis* (coni vasculosi)—these lobules together constitute the head of the epididymis. The ductules then all open into a single tube, the duct of the epididymis, which becomes much coiled on itself and forms the body and tail of the epididymis. If the tunica vaginalis is removed from the body and tail of the epididymis and the fibrous tissue binding the coils is cleaned, a greater part of the duct may be uncoiled.

The **Penis** (Figs. 10, 11) consists of an extremity or *glans penis*, a *body*, and a *root*. At the extremity the skin is doubled on itself and passes backwards to the base of the glans and is thence reflected on the surface of the glans to be continuous with the mucous membrane of the external urethral orifice. This loose fold of skin is called the *prepuce.* Below the urethral orifice a triangular fold passes to the prepuce. This is called the *frenulum preputii.*

Dissection. Make a longitudinal incision along the middle line of the dorsum of the penis and reflect the skin on either side.

The *superficial fascia* covering the penis consists of loose areolar tissue and like the tunica dartos of the scrotum it is devoid of fat. The *superficial dorsal vein of the penis* runs backwards in the superficial fascia along the median line and terminates in the superficial external pudendal vein.

The *suspensory ligament of the penis* is a triangular band composed of fibrous and elastic tissue. It is attached by its apex to the front of the symphysis pubis. Its base, reaching the dorsum of the organ, splits into two lateral laminæ which become blended with the deep fascia at the sides of the penis.

The *fundiform ligament of the penis* begins from the linea alba and divides into two parts which pass one on either side

of the penis and unite below, blending with the septum of the scrotum.

The *deep fascia of the penis* covers the dorsal vessels and nerves of the organ and extends forwards up to the glans. It receives the aponeurotic insertions of the ischiocavernosus and the bulbo cavernosus.

Dissection. Divide the deep fascia along the median line of the dorsum of the penis and reflect it on either side. The deep dorsal vein of the penis is seen in the middle line and on each side of the vein the dorsal artery and dorsal nerve of the penis are seen between the two laminæ of the suspensory ligament. Trace these vessels and nerves on the dorsum of the penis.

The *deep dorsal vein of the penis* is formed by minute veins from the glans. It passes backwards in the groove along the middle line of the dorsum of the penis, and then between the two laminæ of the suspensory ligament. Then it sends a communicating twig to the internal pudendal vein and enters the pelvis below the pubic arcuate ligament to join the pudendal venous plexus.

The *dorsal arteries of the penis* are the terminal branches of the internal pudendal arteries. They pass forwards between the two laminæ of the suspensory ligament to the glans on either side of the deep dorsal vein.

The *dorsal nerves of the penis* are branches of the pudendal nerve. They pass forwards between the two laminæ of the suspensory ligament on the lateral side of the dorsal arteries and terminate in the glans.

The **body of the penis** (Fig. 11) consists of three cylindrical masses, viz., the two corpora cavernosa penis which are placed side by side and are situated dorsally, and the corpus cavernosum urethræ which is situated in the median longitudinal groove on the under surface of the two corpora. Traced behind the two corpora diverge and become the crura of the penis (p. 8). Traced in front each corpus presents a small dilatation, the *bulb of the corpus cavernosum penis,* just before it meets its fellow of the opposite side ; the corpus then continues its course with a uniform diameter and ends in a blunt rounded extremity which receives the glans penis. The corpus cavernosum urethræ presents behind an enlargement called the *bulb of the urethra* which lies attached to the inferior fascia of the urogenital diaphragm. Its anterior end presents a conical expansion called the *glans penis ;* the projecting margin of the base of the glans is called the *corona glandis.* It is traversed by the cavernous

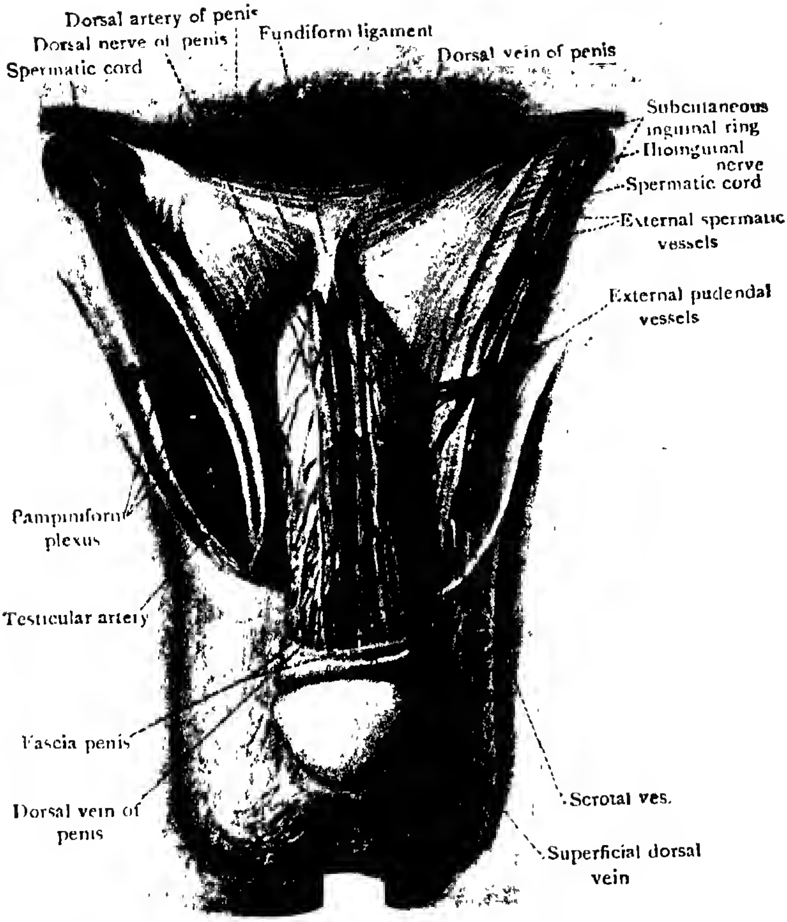


Fig. 10.—The spermatic cord and dorsum of the penis (Sobotta).

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III

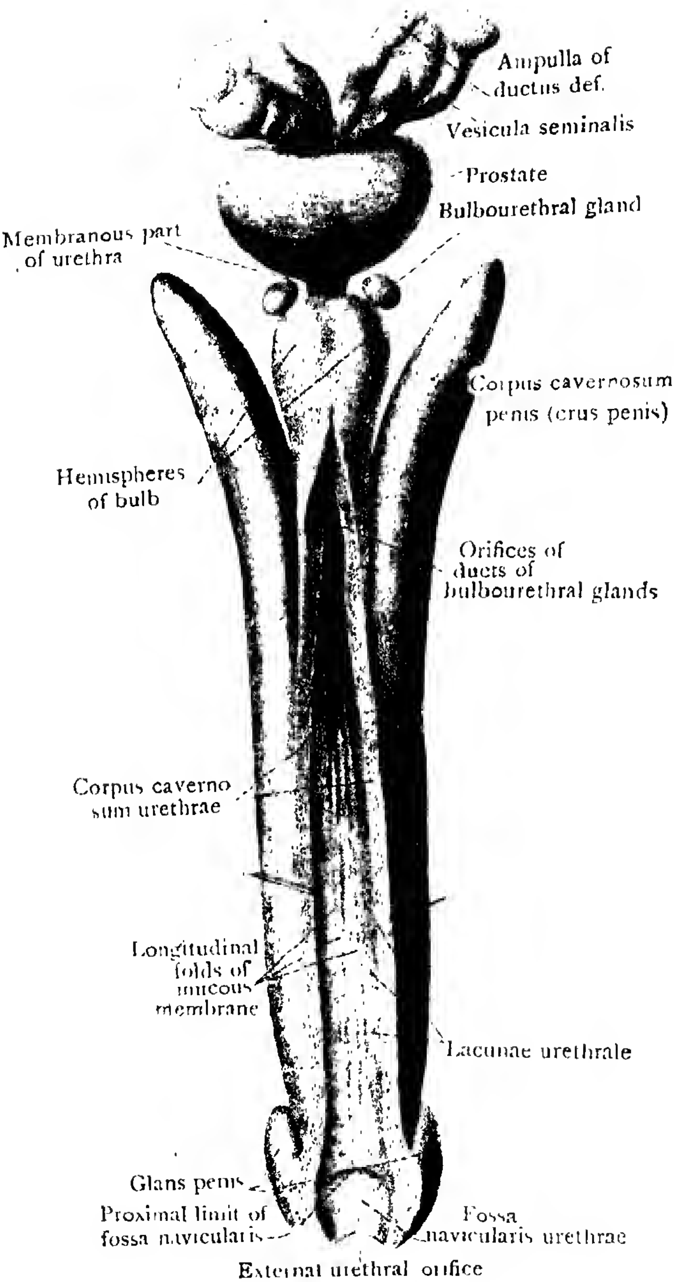

Fig. 11 —The component parts of the penis (Sobotta).

portion of the urethra which is about six inches long and terminates at the external urethral orifice at the summit of the glans.

The **root of the penis** is formed by the two diverging crura of the penis and the urethral bulb. The crura have already been examined (p. 8).

Structure of the corpus cavernosum penis and *urethræ.*—The corpora cavernosa penis are enclosed by a strong fibrous capsule. From the inner surface of this capsule a vertical septum descends separating the two halves, and is called the *septum of the penis.* It is incomplete in its front part where it consists of vertical bands arranged like the teeth of a comb, and is called the septum *pectiniforme.* From the inner surface of the capsule and the septum processes or trabeculæ pass to the erectile structure of the corpora cavernosa penis subdividing it into venous spaces. Incisions may be made into the corpora cavernosa penis to note their spongy structure. The fibrous capsule of the corpus cavernosum urethræ is thinner and sends trabeculæ from its inner surface, which form meshes smaller than those of the corpora cavernosa penis.

THE ABDOMINAL CAVITY

Dissection. Remove the remains of the sheath of the rectus and the fascia transversalis. The peritoneum is now well exposed. The cavity of the abdomen is to be opened by a vertical cut through the peritoneum from the umbilicus to the xiphoid process a little to the left of the middle line and by a transverse incision at the level of the umbilicus. Reflect the upper two flaps on the costal arch. Raise the lower flap by holding it at the centre of its free margin.

The elevations and depressions found on the posterior aspect of the anterior abdominal wall are now to be studied. The elevations caused by peritoneal folds are :—

(1) The *median umbilical fold* covers the middle umbilical ligament or the urachus and extends from the vertex of the bladder to the umbilicus. (2) The *lateral umbilical folds* cover the obliterated umbilical arteries and extend from the umbilicus to the sides of the bladder one on each side of the medial umbilical fold. (3) The *epigastric folds* lie to the lateral side of the lateral umbilical folds. They cover the inferior epigastric arteries as they proceed towards the umbilicus.

Three *peritoneal fossæ* or shallow depressions are seen on either

side of the middle line bounded by these peritoneal folds. They lie close to the inguinal ligament. The medial one is called (*a*) the *supravesical fossa* and lies between the median and lateral umbilical folds. The intermediate one is called (*b*) the *medial inguinal fossa* and lies between the lateral umbilical fold and the epigastric fold. These two fossæ are situated in the triangular space called Hesselbach's triangle. The lateral fossa is called (*c*) the *lateral inguinal fossa* and is situated lateral to the epigastric fold and the inferior epigastric artery.

Inguinal Hernia is that form of protrusion of a portion of intestine or a peritoneal fold or any other abdominal viscus which passes through the lower portion of the abdominal wall near the inguinal ligament. There are two chief varieties of inguinal hernia: oblique or lateral and direct or medial. The depression in the lateral inguinal fossa corresponds to the abdominal inguinal ring and if any of the contents of the abdominal cavity protrudes through this lateral inguinal fossa it will push the peritoneal pouch in front of it and enter the inguinal canal through the abdominal ring. This variety of hernia is called *oblique inguinal hernia*. In traversing the inguinal canal to the scrotum the protrusion will have the following coverings from within outwards: (1) peritoneum (the sac of the hernia); (2) extra-peritoneal fatty tissue; (3) infundibuliform fascia; (4) cremasteric fascia; (5) external spermatic fascia; (6) superficial fascia; and (7) skin. If on the other hand a protrusion takes place medial to the epigastric artery either through the medial inguinal fossa or through the supravesical fossa the hernia is called *direct inguinal hernia*. This protrusion does not enter the inguinal canal through the abdominal inguinal ring and hence does not get the infundibuliform fascia as its covering. If the hernia occurs through the medial inguinal fossa the coverings of such a hernia will be the same as in the case of oblique inguinal hernia except that the infundibuliform fascia is replaced by fascia transversalis. If the hernia occurs through the supravesical fossa the coverings from within outwards will be: (1) peritoneum (the sac of the hernia); (2) extra-peritoneal fatty tissue; (3) fascia transversalis; (4) inguinal aponeurotic falx; (5) external spermatic fascia; (6) superficial fascia; and (7) skin.

Dissection. Divide the lower flap of the peritoneum by a vertical incision from the umbilicus to the symphysis pubis and reflect the flaps on either side. The contents of the abdomen are now exposed.

Superficial View of the Contents.—Without disturbing the parts the student can see the margin of the liver below the costal arch, the gall-bladder (if it is not empty or collapsed), a portion of the stomach, the great omentum covering the coils of the small intestine, the urinary bladder (behind the symphysis pubis) if distended, and the uterus if pregnant. It happens sometimes that the great omentum is short or drawn up or turned to one side. In that case the coils of the small intestine, the cæcum in the right iliac fossa and the descending colon in the left iliac fossa will also be seen.

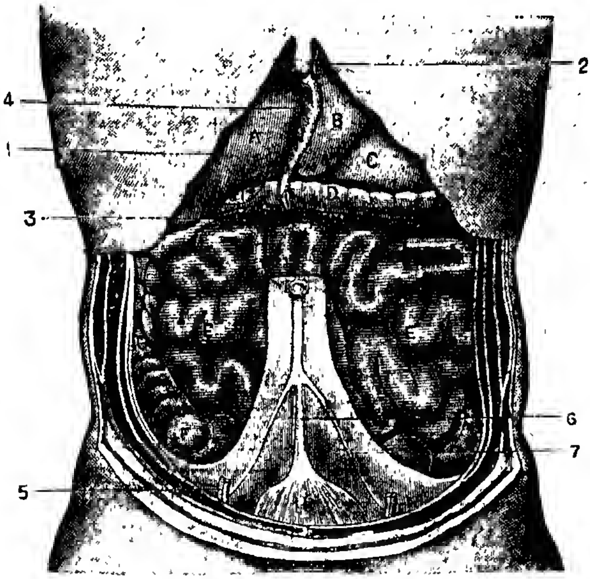

Fig. 12.—Position of the viscera as seen after the removal of the anterior abdominal wall.

A. Right lobe of the liver.
B. Left lobe of the liver.
C. Stomach.
D. Transverse colon.
E. Coils of the small intestine.
F. Cæcum.
G. Ascending colon.
H. Bladder.
I. Gall-bladder.

1. Costal arch.
2. Xiphoid process.
3. Appendices epiploicæ.
4. Falciform ligament of the liver.
5. Inferior epigastric artery.
6. Urachus.
7. Obliterated umbilical artery.

Size, Form, Boundaries, and Subdivisions.—The abdominal cavity is the largest in the body. It is ovoid in form, measuring more in the vertical direction than in the transverse and is much wider above than below. Superiorly it is limited by the dia-

phragm which forms its roof and extends into the thoracic cavity reaching as far as the fifth rib in the mammary line. Inferiorly its floor is formed by the levatores ani and the coccygei which form the diaphragm of the pelvis. Anteriorly and laterally it is limited by the abdominal wall which is partly osseous and partly muscular; while posteriorly is placed the corresponding portion of the vertebral column with the muscles attached to it. The abdominal cavity is artificially subdivided into the *abdomen proper* and *pelvis minor*. An imaginary plane which corresponds to the superior aperture of the lesser pelvis separates these two parts. The abdomen proper contains nearly the whole of the alimentary tube and its appendages together with the spleen, the kidneys and suprarenal glands. The pelvis minor contains chiefly the generative and the urinary organs.

Regions of the Abdomen.—In order to facilitate the description of the situation of the viscera, it is customary with anatomists to divide the abdominal cavity into nine regions by four planes—two passing vertically and two transversally. The two vertical planes are drawn from a point midway between the symphysis pubis and the anterior superior iliac spine vertically upwards. Of the two transverse planes the upper one passes midway between the jugular notch and the symphysis pubis and is called the *transpyloric plane*. The lower one passes close to the prominent tubercles on the outer lips of the iliac crest and is called the *transtubercular plane*; it lies midway between the transpyloric plane and the symphysis pubis. The transpyloric plane is so called because it traverses the pyloric end of the stomach. It also passes through the tips of the ninth costal cartilages. The upper three regions thus demarcated are called the *right hypochondriac*, the *epigastric* (in the middle), and the *left hypochondriac*. The middle three regions are called the *right lumbar*, the *umbilical* (in the middle), and the *left lumbar*. The lower three regions are called the *right iliac*, the *hypogastric* (in the middle), and the *left iliac*. The viscera contained in these regions can not all be seen now.

Directions. The student should now identify and study the situation and relations of the abdominal contents as revealed after the removal of the anterior abdominal wall. For the present dissection with scalpel is not necessary; the forceps or even both hands when required should be used for the purpose. Raise the anterior margin of the liver and fix it to the costal arch with chain-hooks to examine the stomach.

The **Stomach** (Fig. 13) is the most dilated portion of the alimentary canal. It is situated in the left hypochondriac and epigastric regions. When empty (the condition in which it is generally seen in the dissecting room), its walls are in contact with each other. When distended it is more or less pear-shaped. Its upper end or *fundus* constitutes the base of the viscus; it is large and rounded. Its lower end is formed by the *pylorus* which constitutes its apex. The œsophagus opens into the viscus a little below and to the right of the highest point of the organ. This opening is known as the *œsophagea* or *cardiac orifice* of the stomach and is situated at the level of the tenth thoracic vertebra and to the left of the middle line. The *antero-superior surface* of the stomach is in contact above and to the left with the diaphragm, above and to the right with the liver, and between these with the anterior abdominal wall. Its *postero-inferior surface* lies upon (as will be seen afterwards) a certain number of structures which form a shallow sloping bed, called the *stomach-bed*. These structures are:—the diaphragm, the gastric surface of the spleen, the left suprarenal gland, the upper part of the left kidney, the anterior surface of the pancreas, the transverse colon, and the transverse mesocolon. The concave border of the stomach extending between the cardiac and pyloric orifices and lying to the right of the œsophagus is called the *lesser curvature*. It is connected with the lower and posterior

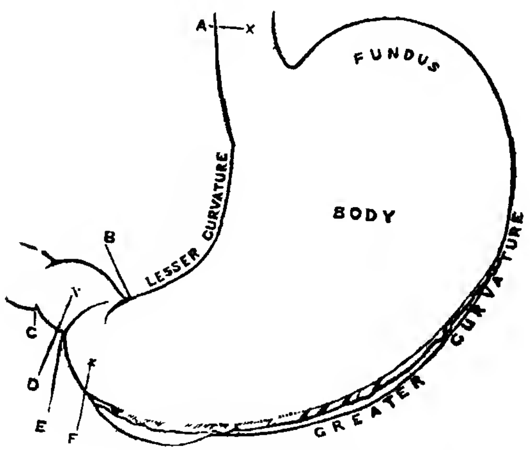

Fig. 13.—The stomach (After Buchanan).

A. Œsophagus.
B. Incisura angularis.
C. Duodeno-pyloric constriction.
D. Pyloric canal.
E. Sulcus intermedius.
F. Pyloric antrum.

surfaces of the liver by a double fold of peritoneum, called the *lesser omentum* or *gastro-hepatic ligament*. The convex border

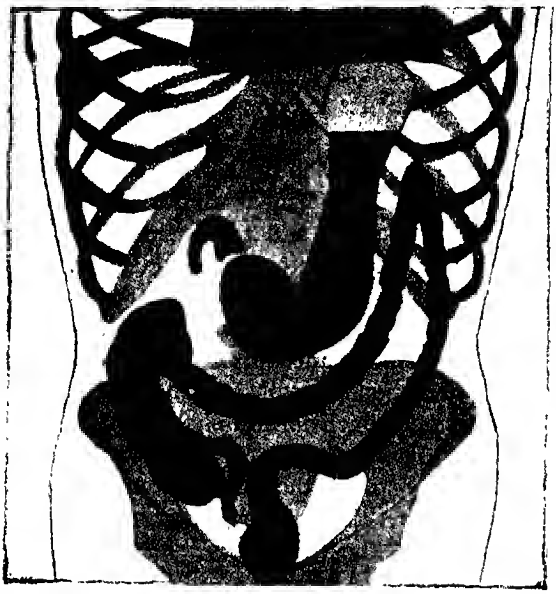

Fig. 14.—Radiograph of a normal stomach in the vertical position. (From A. F. Hertz).

of the stomach is very long and is called the *greater curvature*; it begins from the cardiac orifice and runs upwards and backwards and to the left; it then proceeds downwards and forwards and to the left; finally it turns to the right to end in the pylorus with its convexity directed downwards. Near the œsophagus the greater curvature is connected to the diaphragm by the gastrophrenic ligament; its descending part is connected with the spleen by the gastro-lienal ligament; and its lower part is connected with the transverse colon by a double fold of peritoneum called the *greater omentum* or *gastro-colic ligament*. The stomach presents at its termination a circular constriction on the surface, the *duodeno-pyloric constriction*, which indicates the position of the *pyloric orifice* by which the stomach opens into the duodenum. This orifice is situated at the level of the upper border of the first lumbar vertebra and to the right of the middle line.

The student should distinctly understand that the description

of the stomach given above is what is seen in the dissecting room but the form and position of the stomach vary with the posture and the amount of its contents. By means of X-Rays this subject has been studied in the living person after the administration of a meal containing bismuth. Radiographs of stomachs are depicted in Figs. 14, 15.

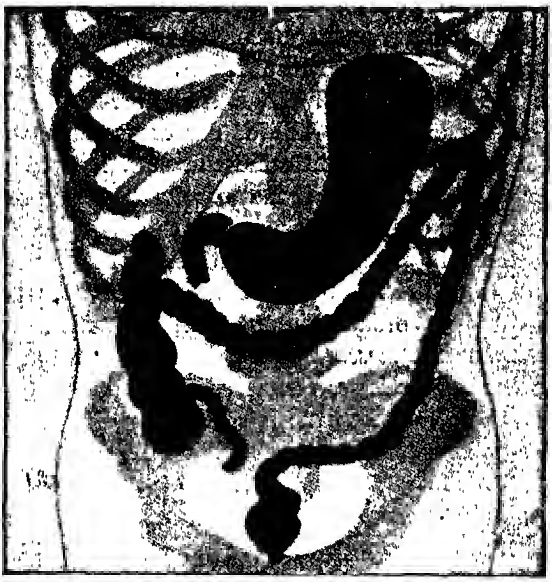

Fig. 15.—Radiograph of a normal stomach in the horizontal position. (From A. F. Hertz.)

The **Small Intestine** begins at the duodeno-pyloric constriction and ends at the colic valve where the large intestine begins ; it is divided into three portions ; the duodenum, the jejunum, and the ileum.

Directions. To display the duodenum (1) the liver is to be raised ; (2) the great omentum with the attached transverse colon is to be turned up over the costal arch ; (3) the coils of the small intestine are to be drawn to the right.

The **Duodenum** is the first part of the small intestine. It is so called on account of its length being about the breadth of twelve fingers. It begins at the duodeno-pyloric constriction and passes upwards and backwards to the gall-bladder. From here it descends and is concealed by the transverse colon behind

which it passes. Then it crosses the vertebral column from the right to the left and terminates on the left side of the body of the second lumbar vertebra in the jejunum. Since the greater part of it is deeply situated its relations will be studied at a later stage of the dissection.

The **Jejunum** and the **Ileum** form the coils of the small intestine. They lie in the umbilical, hypogastric, and the right and left iliac regions. To see the commencement of the jejunum the directions given for displaying the duodenum should be followed. The upper two-fifths of the coils of the small intestine constitute the jejunum and the lower three-fifths, the ileum. There is however no sharp line of demarcation between these two portions of the small intestine showing the termination of the one or the beginning of the other. The jejunum begins at the termination of the duodenum on the left side of the second lumbar vertebra in a flexure called the *duodeno-jejunal flexure.* The jejunum and the ileum are connected to the posterior abdominal wall by a broad double fold of peritoneum called the *mesentery* or the *mesentery proper.* The termination of the ileum into the cæcum is seen in the right iliac fossa by turning over the small intestine to the left side.

The **Large Intestine** begins at the termination of the ileum in the right iliac fossa and ends in the anus. It is distinguished from the small intestine by (1) its greater calibre, (2) its sacculated appearance, (3) its more fixed position, (4) its possessing small processes of peritoneum containing fat, called the appendices epiploicæ, and (5) the presence of three longitudinal bands, called tænia coli, seen on the surface of the coils. It is subdivided into the cæcum, the ascending colon, the transverse colon, the descending colon, the sigmoid colon, the rectum and the anal canal.

The **Cæcum** is the dilated pouch at the commencement of the large intestine. It lies in the right iliac fossa and is usually not completely covered by peritoneum. It is usually clothed by the membrane anteriorly and on the sides, its posterior aspect being bare and connected by loose areolar tissue with the fascia iliaca. In some cases (about fourteen per cent. of the Hindus, vide Journal of Anatomy, vol. LIII, parts II and III, 1919) it is completely clothed by peritoneum and connected with the iliac fossa by a loose fold of peritoneum called the *mesocæcum.* Connected with its medial and back part is a worm-like tube called the *vermiform process* or *appendix.* It is about three

inches in length with a diameter equal to that of a goose quill. It is traversed throughout its whole length by a canal which opens into the cæcum. It is completely covered by peritoneum and kept in situ by a small peritoneal fold called the *mesentery of the vermiform process.* The vermiform process is usually directed upwards and medialwards but it may occupy any possible position consistent with its mobility. The site of the appendix where it joins the cæcum is indicated on the surface of the body by a point which lies one inch below the mid-point of a line drawn from the anterior superior iliac spine to the umbilicus.

The **Ascending Colon** commences in the right iliac fossa from the cæcum and passes upwards through the right lumbar region to the under surface of the liver. Here the gut bends and turns to the left forming the *right flexure of the colon* (Hepatic flexure). In front of it are the coils of the ileum and the abdominal wall. It is usually covered in front and at the sides by peritoneum and its posterior aspect is usually bare and rests on the fascia covering the iliacus and the quadratus lumborum muscle and the right kidney, being connected with them by a loose areolar tissue. In certain cases (seventeen per cent. in Hindus, vide Journal of Anatomy, vol. LIII, parts II & III, 1919) the ascending colon is completely covered by peritoneum forming a loose fold behind it called the *ascending mesocolon.*

The **Transverse Colon** extends from the right colic flexure transversely to the left and terminates below the spleen in a bend called the *left flexure of the colon* (Splenic flexure). In its course to the left it describes a curve with its convexity directed downwards and forwards. It is connected with the posterior abdominal wall by a long double fold of peritoneum called the *transverse mesocolon.* The transverse colon is in relation above with the liver, gall-bladder, stomach and spleen ; below, with the small intestine ; in front, with the anterior layers of the greater omentum ; behind, with the duodenum, pancreas and small intestine. The left colic flexure is attached to the diaphragm by a fold of peritoneum called the phrenico-colic ligament.

The **Descending Colon** extends from the left colic flexure downwards to the brim of the lesser pelvis where it becomes the pelvic colon. It lies in the left hypochondriac, left lumbar and left iliac regions. In its course it lies over the left kidney. It is usually covered in front and at the sides by peritoneum. But in some cases (twenty five per cent. in Hindus) it is completely

invested by peritoneum which forms a loose fold behind called the *descending mesocolon*. Thus a descending mesocolon is more frequent than a mesocæcum or ascending mesocolon. The term *iliac colon* is sometimes used to denote that portion of the descending colon which extends from the iliac crest to the brim of the lesser pelvis.

The **Sigmoid Colon** also known as the *pelvic colon* hangs like a loop in the pelvic cavity and to display it the coils of small instine should be drawn out of the lesser pelvis. The first part of the loop usually crosses the pelvic cavity between the bladder and the rectum in males or between the uterus and rectum in females towards the right pelvic wall. Thence the second part of the loop arches backwards and to the left to reach the middle line opposite the third piece of the sacrum where it ends in the rectum. It is entirely covered by peritoneum which forms a loose fold behind called the *sigmoid mesocolon*.

The **Rectum** begins opposite the third piece of the sacrum and terminates in the anal canal. Only its upper part can be seen now. The rectum and the anal canal will be studied during the dissection of the pelvis.

The **Liver** (Fig. 27) occupies the right hypochondriac, the epigastric and a part of the left hypochondriac regions. The whole organ can not be studied until it is removed from the abdominal cavity. Under present conditions only such parts and connections are to be studied as are possible with the organ in situ. The *superior surface* of the liver is in relation with the under surface of the diaphragm Push the fingers between the superior surface of the liver and the diaphragm to examine the superior layer of the peritoneal fold, the *coronary ligament*, which proceeds from the liver at the junction of the superior and posterior surfaces to the diaphragm. Examine also the *right* and *left triangular ligament* which also connect the organ to the diaphragm at the right and left extremities respectively of the coronary ligament. The anterior surface is most seen now and is triangular in shape ; it consists of portions of the right and left lobes ; its right and left portions are in contact with the diaphragm and its central part is in relation with the anterior abdominal wall over the subcostal angle. To the superior and anterior surfaces is attached a triangular fold of peritoneum called the *falciform ligament* along the base of which runs a rounded cord, called the *round ligament* or *ligamentum teres*, towards the umbilicus. The *inferior* or *visceral surface* of the liver is in contact with the

right kidney, the right flexure of the colon, the lesser omentum, the pyloric end of the stomach and the commencement of the duodenum. The lesser omentum will be seen passing from the inferior surface of the liver to the lesser curvature of the stomach. The *posterior surface* of the liver is in relation with the diaphragm and cannot be examined at present. The *anterior margin* of the liver is sharp and presents two notches; one is placed opposite the attachment of the falciform ligament and the other is for the fundus of the gall-bladder opposite the cartilage of the ninth rib.

The **Spleen** (Fig. 28) cannot be seen in the normal condition with the parts undisturbed. But if the stomach be drawn to the right and the hand passed into the left hypochondriac region, the organ will be discovered lying obliquely in the abdominal cavity. It lies in the left hypochondriac and epigastric regions. In the present stage of dissection its four surfaces can be felt by passing the hand; the diaphragmatic surface lies in contact with the diaphragm; the gastric, with the postero-inferior wall of the stomach; the renal, with the upper part of the anterior surface of the left kidney; the colic, with the left flexure of the colon. It is connected with the stomach by a double fold of peritoneum called the *gastro-lienal ligament*, and with the left kidney by a similar fold called the *phrenico-lienal ligament.* Examine also the lower end of the spleen, supported by the phrenico-colic ligament.

The **Kidneys** and **Pancreas** are deeply situated and hence their position and relations will be better studied when the superficial viscera have been removed.

The **Uterus** in the female subject is seen lying between the bladder in front and the rectum behind. It is connected on each side with the lateral pelvic wall by a double fold of peritoneum called the *lateral ligament of the uterus* or the *broad ligament.*

The **Peritoneum** (Figs. 16, 17) is a serous membrane which lines the inner surface of the walls of the abdominal and pelvic cavities and is reflected upon all the viscera contained in these cavities, providing partial or complete coverings to them. The portion reflected upon the viscera is termed the *visceral layer* and that which lines the inner surface of the abdominal and pelvic parietes is called the *parietal layer*. As the membrane passes from the abdominal wall to the viscera or from one viscus to another, it forms folds to which different names have been

given. Further, the visceral and the parietal layers of peritoneum are in contact and there is little fluid in the space between them; if however fluid collects in this potential space which is called the *peritoneal cavity*, the condition is called ascites. It may seem difficult to understand the reflections of the peritoneum, since unlike other serous membranes *e.g.*, the pleura or the pericardium, it invests partially or completely a large number of viscera of different shapes and sizes. In order to get an idea of the reflections of the peritoneum the student should remember that wherever it is traced it is one and the same membrane and that after it has invested the viscera and parietes it forms by itself a closed sac. The fact that in the female the peritoneal cavity communicates with the uterine cavity through the uterine tube and is not thus absolutely a closed sac may for the present be disregarded by the student. He should distinctly understand that on opening the abdominal cavity, each and every viscus that is seen in this cavity is completely outside the cavity of this peritoneal sac. What has happened is that the wall of the sac has only been pushed from outside by the abdominal viscera. Some viscera, *e.g.*, the kidneys and bladder have not pushed the wall of the sac much and hence only one of their surfaces is in contact with the membrane; the remaining surfaces have been left bare or uncovered by peritoneum. Some other viscera, *e.g.*, the coils of the jejunum and the ileum have pushed the wall of the sac to a considerable extent so that they have become surrounded almost on all sides by the membrane which leaves a loose double fold of it fixing them to the parietes. But these coils of the small intestine are still outside the cavity of the sac. The ascending and descending colon on the other hand have pushed the peritoneum from outside to such an extent as to get a covering on their anterior and lateral surfaces leaving their posterior surfaces usually bare and in contact with the abdominal parietes. Hence on opening the peritoneal cavity from the front the interior is not found to be even but marked by irregularities caused by the variously projecting viscera over which the wall of the sac has been moulded.

Let us follow the peritoneum in the **vertical direction**. The dissector has seen the lesser curvature of the stomach. Here two layers of peritoncum are found to meet after covering the surfaces of the stomach. These are continued in apposition to the under surface of the liver constituting the *hepato-gastric ligament*. At the porta of the liver the two layers separate—

an anterior and a posterior. The anterior layer passes forwards over the under surface of the liver, lines its anterior and superior

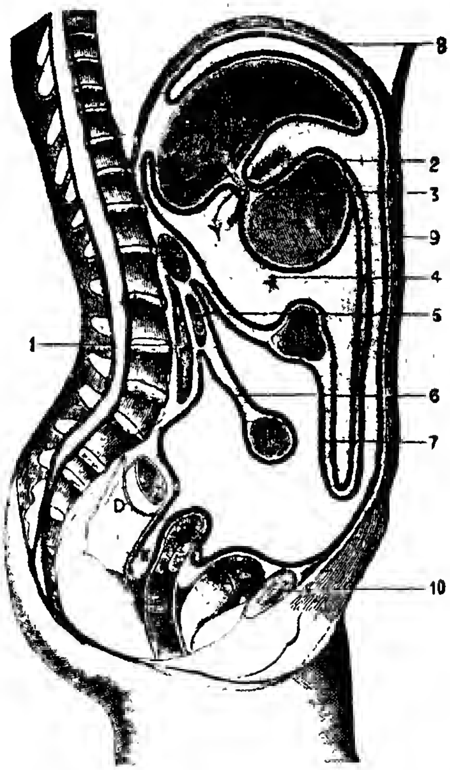

Fig. 16.—Diagram to illustrate the peritoneum as seen in a vertical section.

A. Bladder.
B. Vagina.
C. Uterus.
D. Rectum.
E. Transverse colon.
F. Pancreas.
G. Duodenum.
H. Small intestine.
I. Stomach.
J. Liver.
K. Recto-uterine excavation.
L. Vesico-uterine excavation.

1. Aorta.
2. Arrow indicating the continuation of the greater with the lesser sac.
3. Hepatic artery.
4. Omental bursa.
5. Transverse mesocolon.
6. Mesentery proper.
7. Great omentum.
8. Diaphragm.
9. Anterior abdominal wall.
10. Symphysis pubis.

surfaces and is then reflected upon the diaphragm and becomes continuous with the peritoneum lining the anterior abdominal wall. After lining the whole of the inner surface of the anterior abdominal wall it is reflected on to the bladder and covers it partially. From the bladder it is then reflected on the anterior

surface of the rectum in the male forming a pouch between the bladder and the rectum called the *recto-vesical excavation.* In the female, it is reflected from the bladder to the anterior surface of the uterus, forming a pouch, called the *vesico-uterine excavation.* Having covered the posterior surface of the uterus and the upper part of the posterior wall of the vagina it is reflected on to the anterior surface of the rectum forming a deep pouch, called the *recto-uterine excavation* (pouch of Douglas). Having observed how it covers the front and sides of the upper part of the rectum and completely invests the sigmoid colon forming a loose fold behind it, the *sigmoid mesocolon*, follow it upwards as it lines the posterior abdominal wall and covers the superior mesenteric vessels posteriorly forming the posterior layer of the mesentery. Then it encircles the small intestine and covers the superior mesenteric vessels anteriorly, forming the anterior layer of the mesentery. It then covers the inferior surface of the pancreas and at the anterior border of the gland is reflected downwards forming the inferior layer of the transverse mesocolon. It covers the posterior and inferior surfaces of the transverse colon and from its inferior surface is reflected downwards as the most posterior layer of the free fold called the greater omentum. At the free border of the greater omentum it is folded on itself forming the most anterior layer of the greater omentum. On reaching the greater curvature of the stomach it invests its antero-superior surface and reaches the lesser curvature to become continuous with the anterior layer of the lesser omentum, from where we started tracing. The posterior layer of the lesser omentum passes backwards from the porta of the liver, covers the caudate lobe and caudate process of the liver and is reflected on to the under surface of the diaphragm. Traced downwards it covers the anterior surface of the pancreas and from its anterior border is prolonged as the anterior layer of the transverse mesocolon. Then it covers the anterior and inferior surfaces of the transverse colon and is continued downwards as far as the free border of the greater omentum forming the posterior boundary of the lesser sac. Then it is folded on itself and passes upwards as the posterior layer of the descending part of the greater omentum and forms the anterior boundary of the omental bursa. Then it reaches the greater curvature of the stomach, covers its postero-inferior surface and is prolonged from the lesser curvature as the posterior layer of the lesser omentum from where we started tracing.

If Fig. 16 is looked into, it will be seen that the peritoneal cavity is divided into two sacs which communicate with each other behind the right margin of the lesser omentum through a channel called the *epiploic foramen* (foramen of Winslow). The greater sac is placed in front and the lesser sac, called the *omental bursa,* is placed behind it. Pass your finger behind the right free margin of the lesser omentum into the epiploic foramen and the following boundaries will be felt : *in front,* the free margin of the lesser omentum enclosing between its two layers the portal vein, the hepatic artery and the bile duct ; *behind,* the inferior vena cava covered by peritoneum ; *above,* the caudate process of the liver ; and *below,* the commencement of the duodenum and the hepatic artery before it ascends through the layers of the lesser omentum.

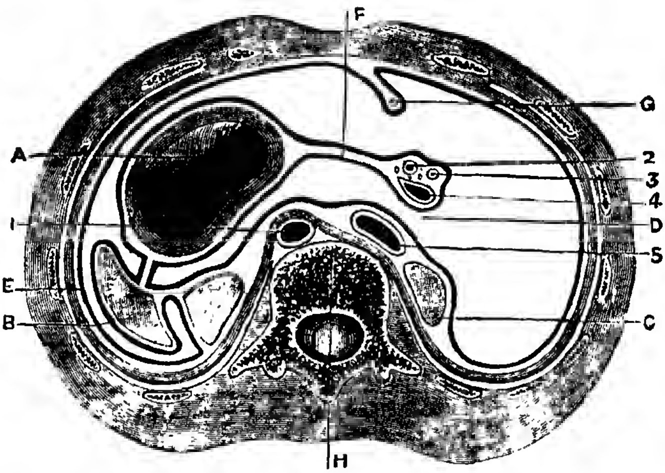

Fig. 17.—Transverse section of abdomen at the level of the epiploic foramen.

A. Stomach.
B. Spleen.
C. Right kidney.
D. Epiploic foramen.
E. Parietal peritoneum.
F. Hepato-gastric ligament.
G. Ligamentum teres.
H. Twelfth thoracic vertebra.

1. Aorta.
2. Hepatic artery.
3. Bile duct.
4. Portal vein.
5. Inferior vena cava.

If the peritoneum is traced **transversely** (Fig. 17) at the level of the epiploic foramen the continuity of the two sacs will be seen. Beginning at the anterior abdominal wall the peritoneum will be found to cover the obliterated umbilical vein in the middle

line forming the falciform ligament. Traced to the left it is reflected from the lateral wall of the abdomen on to the anterior surface of the left kidney. Covering the lateral part of the anterior surface of the kidney it is reflected on to the hilum of the spleen forming the posterior layer of the phrenico-lienal ligament (lieno-renal ligament). Then it covers successively the renal, diaphragmatic and gastric surfaces of the spleen reaching the anterior aspect of its hilum. Thence it passes to the left part of the greater curvature of the stomach forming the anterior layer of the gastro-lienal ligament. Here it covers the antero-superior surface of the stomach and the beginning of the duodenum and is prolonged upwards from the lesser curvature of the stomach as the anterior layer of the lesser omentum. Traced to the right the peritoneum winds round the free margin of the lesser omentum forming the anterior boundary of the epiploic foramen. Traced again to the left it forms the anterior wall of the omental bursa. Tear through the front two layers of the greater omentum below the greater curvature of the stomach and introduce the hand into the omental bursa behind the stomach. The peritoneum forming the anterior wall of the omental bursa passes to the left covering the postero-inferior surface of the stomach and passes to the hilum of the spleen as the posterior layer of the gastro-lienal ligament. Thence it passes to the medial aspect of the anterior surface of the left kidney as the anterior layer of the phrenico-lienal ligament. It then passes to the right across the posterior abdominal wall covering the aorta, the inferior vena cava, the right suprarenal gland and kidney. From here it is reflected on to the anterior abdominal wall from where we started tracing. Thus it will be seen that when the peritoneal cavity is opened through the anterior abdominal wall it is the greater sac that is exposed to view; the lesser sac or the omental bursa being concealed from view behind a vertical partition formed from above downwards by (1) the two layers of the lesser omentum, (2) the stomach and (3) the two anterior layers of the greater omentum. As the vertical partition extends from left to right it is incomplete at its right margin where the lesser sac can be explored by raising the free margin of the lesser omentum and pushing the finger through the epiploic foramen lying behind it. The omental bursa is thus a part or diverticulum of the greater sac and remains concealed behind the vertical partition already mentioned.

In the lower abdomen the arrangement of the peritoneum

presents a simpler condition if traced transversely. Starting from the linea alba and proceeding to the right the membrane lines the inner surface of the anterior and lateral abdominal wall, and on the posterior wall covers the ascending colon anteriorly and at the sides. Then it passes towards the vertebral column and covers the superior mesenteric vessels on their right side. Encircling the small intestine it is reflected on the left side of the superior mesenteric vessels thus completing the mesentery. Traced further to the left it covers the front and sides of the descending colon and is then reflected on to the lateral and anterior abdominal wall back to the linea alba from where we started tracing.

Omental Bursa (Lesser Sac) (Fig. 16).—The student has examined the anterior wall of the omental bursa. He has explored the bursa by passing his finger through the epiploic foramen and by tearing through the two anterior layers of the greater omentum and has felt most of the structures forming its posterior wall. He is now in a position to follow the boundaries of the bursa. It is bounded in front by the caudate lobe of the liver, the lesser omentum, the stomach, and the two anterior layers of the greater omentum. Behind it is bounded from below upwards by the two posterior layers of the greater omentum, the transverse colon, the ascending layer of transverse mesocolon, the anterior surface of pancreas, the left suprarenal gland, the left kidney, the diaphragm, the aorta and the inferior vena cava. On the left side the sac extends to the hilum of the spleen and on the right side it communicates with the greater sac through the epiploic foramen.

Subdivisions of the Omental Bursa.—The omental bursa is subdivided into a vestibule and three recesses, superior, middle and inferior. The *vestibule of the omental bursa* is the narrow passage leading from the epiploic foramen to the left. It is bounded above by the caudate process of the liver, below by the head of the pancreas and the superior portion of the duodenum, and in front by the hepato-duodenal ligament enclosing the hepatic artery, bile duct and portal vein. A pouch of the omental bursa, called the *superior recess*, passes upwards from the vestibule between the caudate lobe of the liver in front and the aorta and crura of the diaphragm behind. The *middle recess* lies behind the lesser omentum. The vestibule and the superior and middle recesses together form the *bursa omenti minoris*. The *inferior recess* or the *bursa omenti majoris* lies behind the stomach and

extends downwards to the lower limit of the omental bursa. When the anterior wall of the omental bursa will be completely removed later on, the gastropancreatic folds producing constriction of the bursa will be noticed.

In tracing the peritoneum through its many reflections the dissector has noticed certain terms applied to designate its several folds. These folds are classified as (1) omenta, (2) mesenteries, and (3) ligaments. The folds which unite the stomach with other viscera are called *omenta* viz , the lesser omentum and the greater omentum. The folds which unite portions of the intestine with the abdominal wall are called *mesenteries*. These are: the mesentery, the mesentery of the vermiform process the transverse mesocolon, and the sigmoid mesocolon, and sometimes an ascending and a descending mesocolon. Other peritoneal folds which connect one viscus with another are called *ligaments*, which term is thus very broadly used.

The *lesser omentum* is a double fold of peritoneum which extends from the lesser curvature of the stomach and the first part of the duodenum to the porta of the liver The portion of it between the liver and the stomach is called the *hepato-gastric* ligament ; and the portion lying between the liver and the duodenum is called the *hepato-duodenal ligament*. Between the two layers of the lesser omentum near the right free margin will be seen the bile duct, the hepatic artery and the portal vein.

The *greater omentum* is the largest fold of peritoneum and consists of four layers. The two layers which leave the greater curvature of the stomach and the first part of the duodenum descend for a considerable distance in front of the small intestine and then ascend folding on themselves to the under surface of the transverse colon where they split to enclose that portion of the gut. These four layers can not be demonstrated as separate layers in the adult. To the left it is continuous with the gastro-lienal ligament.

The *mesentery* (mesentery proper) is the double fold of peritoneum which connects the jejunum and ileum to the posterior abdominal wall. Its posterior border or *root* is attached along a line extending from the left side of the second lumbar vertebra (the commencement of the jejunum) to the right iliac fossa (the termination of the ileum) and is narrow being about six inches long. The anterior border is very broad, about twenty feet in length and encloses the small intestine. Between its

two layers are contained the superior mesenteric vessels and plexus of nerves, the lymphatic vessels and mesenteric lymph glands. The *transverse mesocolon* is the broad transverse fold of peritoneum connecting the transverse colon to the posterior abdominal wall along the anterior border of the pancreas. It does not extend along the whole length of the transverse colon but ceases near a point corresponding to the right of the head of the pancreas. It contains between its layers vessels nerves and lymphatics of the transverse colon. The *sigmoid mesocolon* is a V-shaped fold with its apex near the bifurcation of the left common iliac artery. Between its two layers are seen the sigmoid and superior hæmorrhoidal vessels.

The *ligaments* formed by peritoneal folds will be examined when the viscera are studied in detail.

Certain *peritoneal fossæ* or pouches are now to be examined. (1) The *duodenal fossæ* are five in number. (*a*) The *inferior duodenal fossa* is present in about seventy five per cent. of subjects. It is situated opposite the third lumbar vertebra to the left of the ascending portion of the duodenum. It has its orifice looking upwards. (*b*) The *superior duodenal fossa* is present in about fifty per cent. of subjects. It is situated opposite the second lumbar vertebra to the left of the ascending part of the duodenum. Its orifice looks downwards. (*c*) The *duodeno-jejunal* or *meso-colic fossa* is present in about fifteen to twenty per cent. of subjects. It is situated above the duodeno-jejunal flexure between the aorta and the left kidney and its orifice is directed forwards. (*d*) The *paraduodenal fossa* is situated a short distance to the left of the ascending portion of the duodenum under cover of a free fold of peritoneum containing the ascending branch of the left colic artery and the inferior mesenteric vein. Its orifice is directed towards the right. (*e*) The *retro-duodenal fossa* is sometimes met with ; it extends upwards between the abdominal aorta and the ascending portion of duodenum. Its orifice looks downwards. (2) The *cæcal fossæ* are three in number. (*a*) The *superior ileo-cæcal fossa* is situated above the ileo-colic junction and is formed by a fold of peritoneum covering the ileo-colic artery which supplies the junction. (*b*) The *inferior ileo-cæcal fossa* is situated below the ileo-cæcal junction. It lies in front of the mesentery of the vermiform process and behind the terminal part of the ileum. (*c*) The *cæcal fossa* lies behind the cæcum and is seen by raising the gut. (3) The *intersigmoid fossa* is situated to the left of the sigmoid colon on the external iliac vessels. It is present

in the fœtus and infancy but disappears with advance of age. (4) The *recto-vesical*, the *recto-uterine* and the *vesico-uterine fossæ* or excavations have been already referred to.

Dissection. Raise the greater omentum and transverse colon and throw them over the thoracic wall. Draw the small intestine downwards and to the left and spread them out in a fan-like manner. The anterior layer of the mesentery is then to be removed. This removal should be commenced at the jejunum and continued till the end of the ileum is reached. Remove also the inferior layer of the transverse mesocolon as also the peritoneum directed towards the cæcum and the ascending colon over the posterior abdominal wall. The superior mesenteric artery and its branches will now be seen.

The **Superior Mesenteric Artery** (Fig. 18) supplies the whole of the small intestine, the cæcum, the ascending colon and the right half of the transverse colon. It arises from the abdominal aorta behind the pancreas. Then it crosses the lower part of the head of the pancreas and the horizontal part of the duodenum and descends between the two layers of the mesentery proper till it reaches the right iliac fossa Here it anastomoses with one of its branches, the ileo-colic artery, forming an arch the concavity of which is directed towards the right side. It is surrounded by the superior mesenteric plexus of nerves.

Branches.—(1) The *inferior pancreatico-duodenal artery* arises from the upper part of the superior mesenteric or sometimes from its first jejunal branch It passes to the right between the head of the pancreas and duodenum, supplies both, and anastomoses with the superior pancreatico-duodenal artery. (2) The *jejunal* and *ileal branches* (vasa intestini tenuis) are twelve to fifteen in number. They arise from the convexity of the arch. Each of them divides into two branches which by their union with the contiguous branches form a series of arches. From the convexities of these arches small branches are given off which divide and anastomose in a similar manner forming a second series of arches. Thus a third, a fourth, or even a fifth series of arches are formed. From the convexity of the most peripheral arches small branches are given off which encircle the intestine and supply them. (3) The *ileo-colic artery* arises from the concavity of the superior mesenteric artery. It passes downwards and to the right behind the peritoneum and divides into two branches a superior and an inferior. The superior branch ascends and anastomoses with the right colic artery. The inferior branch

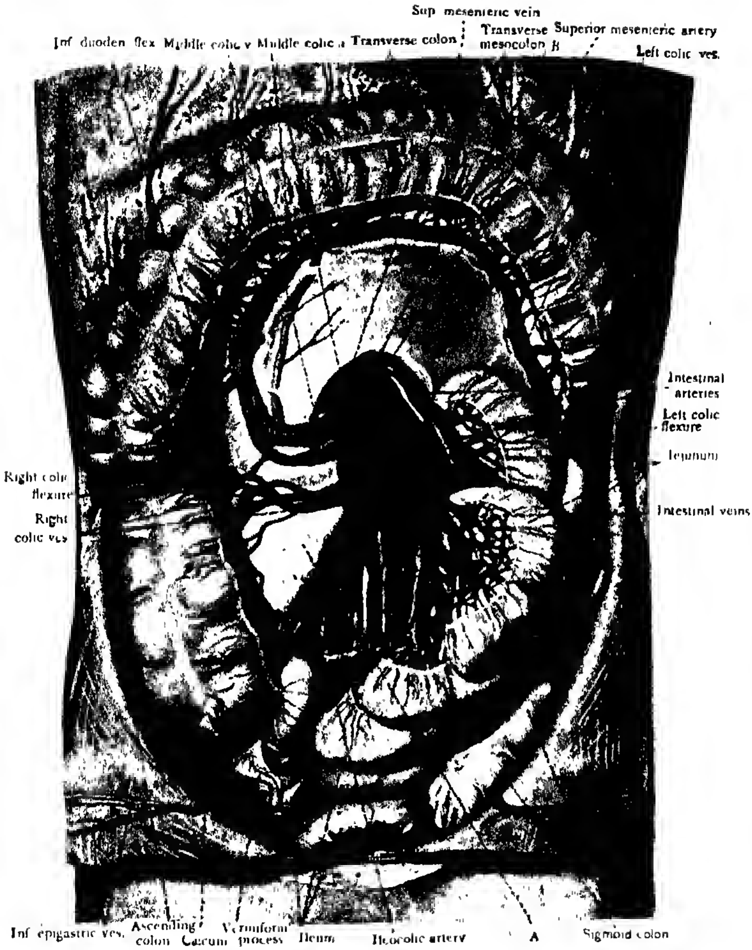

Fig. 18.—Dissection of the superior mesenteric artery (Sobotta).

A & B—Transverse mesocolon.

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gives off the following branches :—(*a*) colic branches which pass upwards on the ascending colon, (*b*) anterior and posterior cæcal branches which supply the front and back of the cæcum, (*c*) appendicular artery which descends behind the last part of the ileum and passes along the mesentery of the vermiform process to supply that process, (*d*) ileal branch which passes to the left along the ileum and communicates with the termination of the superior mesenteric artery. (4) The *right colic artery* or colica dextra arises from the concavity of the superior mesenteric artery above the ileo-colic or sometimes in common with it. It passes towards the ascending colon and divides into an ascending and a descending branch. The former anastomoses with the middle colic and the latter with the superior branch of the ileo-colic. From the anastomotic arch twigs pass to the ascending colon. (5) The *middle colic artery* or colica media arises from the superior mesenteric artery just below the pancreas. It passes forwards between the two layers of the transverse mesocolon and divides into a right and a left branch. The right branch anastomoses with the ascending branch of the right colic artery and the left branch with the left colic artery. From the anastomotic arch twigs pass to supply the transverse colon.

The **Superior Mesenteric Vein** lies to the right side of its companion artery. It receives tributaries corresponding to the branches of the artery, passes behind the pancreas and there unites with the splenic vein to form the portal vein.

The **Superior Mesenteric Plexus** consists of nerve filaments derived from the plexus of the sympathetic around the cœliac artery. These nerve filaments surround the superior mesenteric artery and accompany its branches to the intestine.

Observe the numerous lymph glands, more than one hundred in number, each about the size of a pea lying between the two layers of the mesentery. These are called the *mesenteric lymph glands* and are arranged in three sets : one lying near the intestine; a second lying in relation with the main branches of the jejunal and ileal arteries ; the third along the trunk of the superior mesenteric artery. Radiating from these glands are white, thread-like structures. These are the lymphatic vessels : the lymphatic vessels of the small intestine are called *lacteals* or *chyliferous vessels.* These lacteals pass through the mesenteric glands to terminate ultimately in the thoracic duct.

Dissection. Turn over the coils of the small intestine to the right side. Remove the peritoneum that lies over the lower

part of the aorta and the space between the left side of the vertebral column and the descending colon. The inferior mesenteric artery will now be seen . On the artery and its branches the inferior mesenteric plexus of nerves will be seen. This should be preserved as also the plexus of nerves which lies over the lower part of the aorta. The inferior mesenteric vein should be traced upwards beneath the pancreas up to its union with the splenic vein.

The **Inferior Mesenteric Artery** (Fig. 19) arises from the abdominal aorta an inch and a half above its bifurcation. It passes downwards and to the left, crosses the left common iliac artery and is continued as the superior hæmorrhoidal artery into the rectum. *Branches.*—(1) The *colica sinistra* or the left colic artery passes to the left and divides into an ascending and a descending branch. The former ascends to anastomose with the left branch of the middle colic artery. The latter anastomoses with the highest sigmoid artery. From the anastomotic arch twigs are supplied to the left part of the transverse colon and the descending colon. (2) The *sigmoid arteries* are two or three in number. They pass downwards and to the left. The highest one anastomoses with the descending branch of the left colic and the lowest one with the superior hæmorrhoidal artery. They supply the lower part of the descending colon and the sigmoid colon. (3) The *superior hæmorrhoidal artery* supplies the rectum and will be traced during the dissection of the lesser pelvis.

The **Inferior Mesenteric Vein** receives tributaries corresponding to the branches of the artery. It ascends along the left side of the artery and opens into the splenic vein behind the pancreas.

The **Inferior Mesenteric Plexus** consists of nerve filaments prolonged from the aortic plexus of the sympathetic. It surrounds the inferior mesenteric artery and offsets are given off from it along the branches of the artery to be distributed to the left half of the large intestine.

The **Abdominal Aortic Plexus** may now be displayed upon the sides and front of the aorta between the origins of the superior and inferior mesenteric arteries. Its further connections will be examined at a later stage of the dissection.

Dissection. Remove the intestine with the exception of the duodenum and the rectum from the abdominal cavity. Place two ligatures about half an inch apart, on the upper end of the

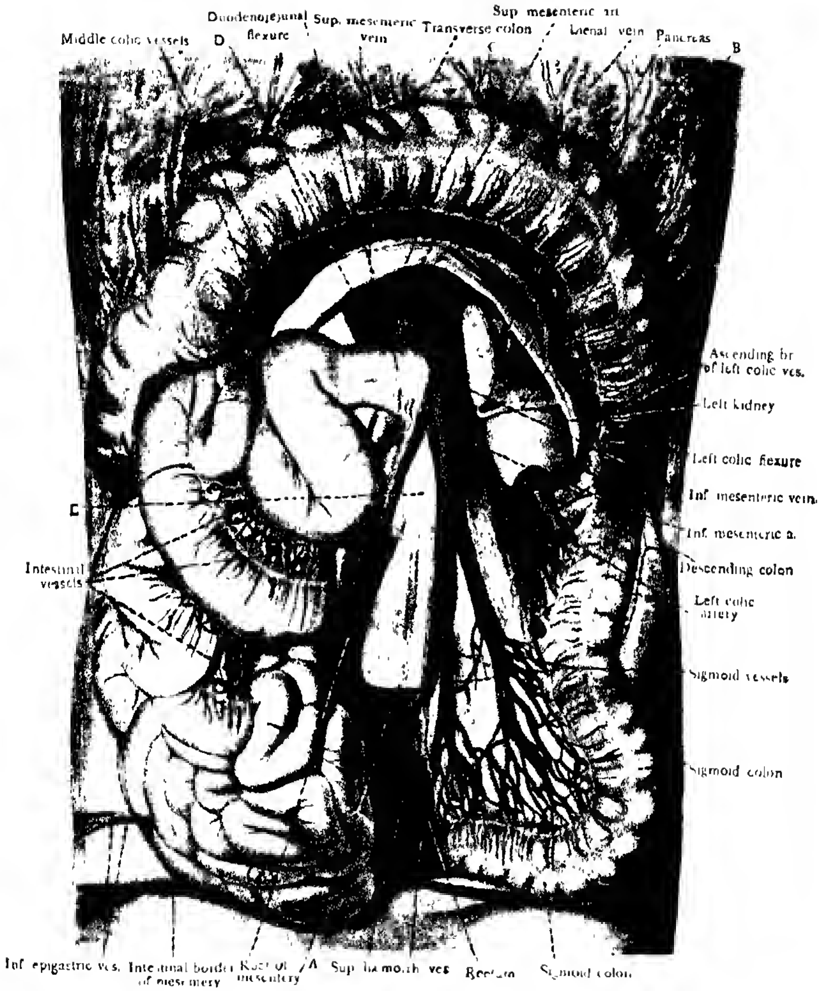

Fig. 19.—Dissection of the inferior mesenteric artery (Sobotta).

A & E—Peritoneum of mesentery. B, C & D—Transverse mesocolon.

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jejunum below the duodeno-jejunal flexure and divide the bowel between the two. Similarly apply two ligatures on the lower end of the sigmoid colon and divide the gut between the two. Cut through the mesentery close to the wall of the gut. The whole of the intestine between these points should then be removed and properly cleaned by allowing a stream of water from the tap to run freely through the lumen of the gut after removing the ligatures. Proceed then to prepare the following specimens:—(1) Cut through the ascending colon four inches above the ileo-cæcal orifice and also through the ileum four inches from that orifice. Wash through this detached part again which consists of a portion of the ascending colon, the cæcum and the lower portion of the ileum. Ligature the gut at one end; then inflate this portion of the gut and tie the other end. Let it now be hung up to dry. (2) From the remaining portion of the lower end of the ileum take about six inches and (3) a similar portion from the upper part of the jejunum. Slit these open with scissors along the line of attachment of the mesentery. (4) Next lay open a portion of the colon, about six inches long, in the same manner. Put these specimens in a shallow dish containing water and pin them out on cork with the mucous membrane uppermost. The rest of the intestine should be kept in a preservative solution and specimens are to be made when directed later on.

Mucous Membrane of the Intestine (Figs. 20, 21, 22).—The dissector will now see the differences presented in the mucous membrane in the different portions of the gut. In the specimen of the jejunum the mucous membrane is thrown into transverse folds called the *plicæ circulares* (Valvulæ conniventes). These folds are not obliterated if the gut is distended or stretched and are permanent folds. Most of these folds extend transversely across the lumen for about one-half or two-thirds of the circumference. Some form complete circles and a few will be seen passing two or three turns in the form of a spiral round the lumen. In the upper part of the jejunum (specimen under examination) they are large and very closely set. If a portion of the jejunum lower down is opened they will be seen to diminish in number and size. Further down, in the ileum they become fewer and less prominent and in the lower fourth of the ileum they are absent altogether. The function of these circular folds is (1) to retard the progress of food along the intestine and (2) to afford a greater surface for absorption. Each fold is composed of a doubling of the mucous membrane which encloses submucous tissue.

If the specimen from the lower end of the ileum is examined the dissector may see one or more circular or oval patches called *aggregated lymph nodules* (Peyer's patches) (Fig. 22). If they are not found in the specimen under examination another portion from the lower part of the ileum may be opened and looked for by holding the gut up against the light. They are one to four inches in length and their total number varies from twenty to thirty. They are placed lengthwise with their long axis parallel to the length of the lumen and situated opposite the attachment of the mesentery. They are largest and most numerous in the ileum and become fewer and smaller in the jejunum. They are most developed in the young, become indistinct in middle age and sometimes disappear altogether in old people.

The *solitary lymph nodules* are seen scattered throughout the entire length of the intestinal canal but they are most numerous in the lower part of the ileum. They are small rounded bodies, about the size of mustard seed, projecting slightly from the surface of the mucous membrane and are covered with villi.

The *intestinal glands* (crypts of Lieberkuhn) are minute tubular glands seen throughout the small intestine. Their small orifices may be seen on the surface of the mucous membrane between the villi with the aid of a lens as they cannot be recognised with the naked eye.

If the portion of the gut from the upper part of the jejunum as it floats in the dish be examined with a pocket lens, minute processes called *villi* projecting from the surface of the mucous membrane will be seen. They exist upon the surface of the circular folds and in the spaces between them as well. They are found in large numbers and most distinctly developed in the upper part of the small intestine. They diminish in number and size in the ileum.

The *mucous membrane of the large intestine* presents a striking contrast to that of the small gut. In the portion of the colon which has been laid open it will be seen that there are neither circular folds nor villi, nor aggregated lymph nodules ; but solitary lymph nodules are found in large numbers.

Structure of the Intestine (Fig. 20).—Four coats enter into the formation of the walls of the large and of the small gut. These are (1) serous, (2) muscular, (3) submucous, and (4) mucous.

The *serous coat* is derived from the peritoneum. It completely invests the superior portion of the duodenum and also the jejunum

Fig 20.—A portion of the upper part of the jejunum.

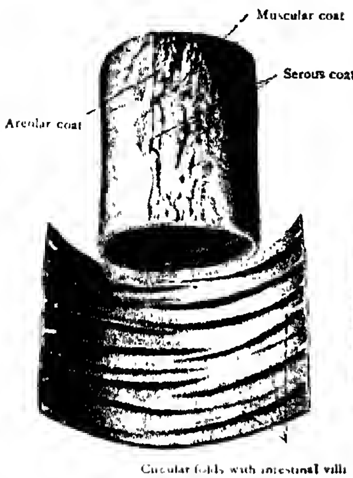

Fig. 21.—A portion of the lower part of the jejunum

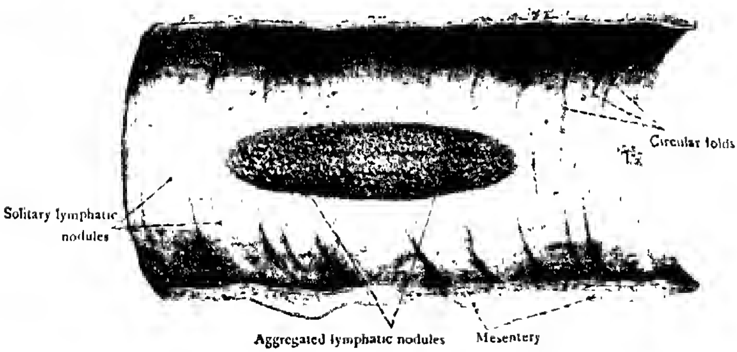

Fig. 22.—A portion of the lower part of the ileum. (Sobotta)

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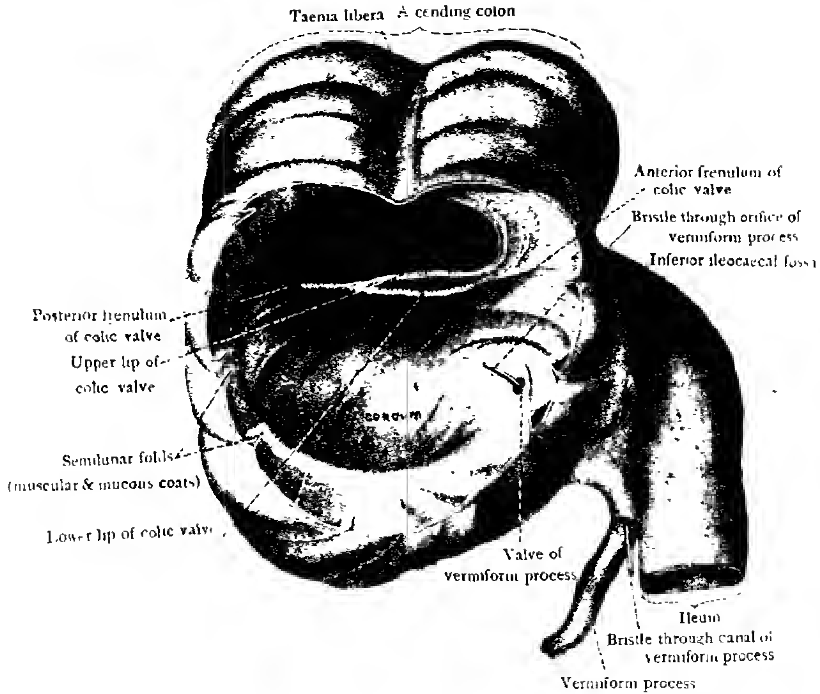

Fig. 23 —The interior of the cæcum showing the colic valve (Sobotta).

and the ileum except at the line of attachment of the mesentery. It invests the different portions of the large intestine to a variable extent. In the large intestine small processes of peritoneum project from the free margin of the gut; these form pouches and contain fat. They are called *appendices epiploicæ* and are characteristic of the large intestine. They are not found in the rectum.

The *muscular coat* will be exposed on removing the serous covering. It consists of fibres arranged in two layers viz., an external layer of longitudinal fibres and an internal layer of circular fibres. In the small intestine the longitudinal layer is thin but the muscular fibres are spread out uniformly over the circumference of the gut; the circular layer is thick. In the cæcum and colon the external layer of longitudinal fibres instead of being uniformly distributed over the gut is collected into three longitudinal bands called *tæniæ coli;* the first, the posterior called the *tænia mesocolica*, placed along the attached border of the intestine; the second the anterior or *tænia omentalis*, the largest, and situated in front of the ascending, the descending, and the sigmoid colon and along the attachment of the greater omentum in the transverse colon; the third, called the *tænia libera*, placed along the medial side of the ascending and descending colon and on the under surface of the transverse colon. These bands if traced in the cæcum will be found to converge to the vermiform process. They are shorter than the length of the tube and hence if they are divided the tube lengthens. The sacculation of the large intestine is due to the presence of these longitudinal bands. The circular muscle fibres of the large intestine form a thin layer and are uniformly distributed.

The *submucous coat* consists of loose areolar tissue binding the muscular layer to the mucous layer.

The *mucous coat* has been already examined (p. 61).

Dissection. Now examine the interior of the dried specimen of the cæcum with portions of ileum and ascending colon attached to it. Remove the lateral wall of the distended cæcum. The ileo-cæcal orifice and the valve guarding it are now seen.

The *ileo-cæcal orifice* is an antero-posterior aperture seen at the lower end of the ileum where it opens into the point of junction of the cæcum with the colon. It is bounded by two segments of the colic valve.

The **Colic Valve** (Ileo-cæcal valve) (Fig. 23) guards the cæcal orifice. It consists of two projecting segments or lips,

an upper and a lower. They are formed by a prolongation of the mucous membrane and of submucous tissue and circular muscle fibres. The upper segment is horizontal, and its ends coalesce with those of the lower one. The lower one is larger and oblique. Two ridges are continued on the inner surface of the wall of the cæcum from where the ends of the two segments coalesce. These are called the *frenula* of the valve. The function of the valve is to prevent to a large extent reflux of the contents of the cæcum into the ileum but it should be clearly understood that the circular muscular fibres at the end of the ileum act as a true sphincter muscle.

Examine also in this specimen the orific of the vermiform process which is situated behind and below the ileo-cæcal opening and is sometimes guarded by a valve composed of mucous membrane.

Dissection. The cœliac artery and its branches should now be dissected. Draw the stomach downwards. Raise the liver and fix it to the ribs by chain hooks. Remove the anterior layer of the lesser omentum. Clean the vessels lying along the lesser curvature of the stomach and the structures lying between the two layers of the lesser omentum near its right free margin. These are (1) the hepatic artery to the left, (2) the bile duct to the right and (3) the portal vein between and behind the two. When both layers of the lesser omentum are removed, the peritoneum which forms the posterior wall of the omental bursa is exposed. Pull the stomach and note that two peritoneal folds are seen projecting forwards from the posterior wall of the omental bursa. One of these, the *left gastro-pancreatic fold* passes from the pancreas upwards to the cardiac orifice covering the left gastric artery. The other, the *right gastro-pancreatic fold* passes from the upper border of the pancreas towards the pyloric orifice of the stomach covering the hepatic artery. These projecting folds produce a constriction in the omental bursa. Peel off the peritoneum forming the posterior wall of the omental bursa, commencing below from the upper border of the pancreas. Clear the cœliac artery and note that it is surrounded by a plexus of nerves, called the cœliac plexus.

The **Cœliac Artery** (Cœliac axis) (Fig. 24) is a short thick trunk, about half an inch in length. It arises from the front of the abdominal aorta just below the aortic hiatus of the diaphragm and above the superior border of the pancreas. It passes hori-

zontally forwards and divides into three branches viz., the left gastric, the hepatic, and the lienal or splenic.

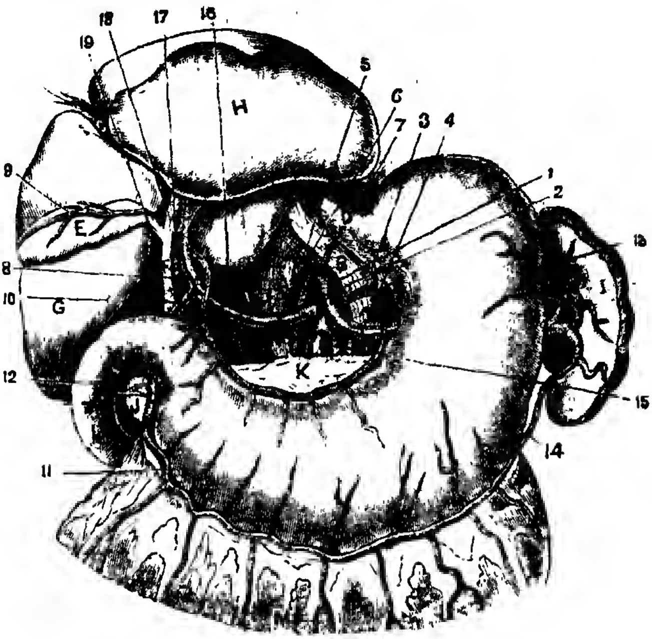

Fig. 24.—The cœliac artery and its branches.

A. Right crus of diaphragm.
B. Left crus of diaphragm.
C. Round ligament of liver.
D. Œsophagus.
E. Gall-bladder.
F. Bile duct.
G. Right lobe of liver.
H. Left lobe of liver.
I. Spleen.
J. Head of pancreas.
K. Body of pancreas.
L. Duodenum.
M. Greater omentum.

1. Abdominal aorta.
2. Cœliac artery.
3. Left gastric artery.
4. Splenic artery.
5. Hepatic artery.
6. Right inferior phrenic artery.
7. Left inferior phrenic artery.
8. Right gastric artery.
9. Cystic artery.
10. Gastro-duodenal artery.
11. Gastro-epiploica dextra.
12. Pancreatico-duodenalis superior.
13. Short gastric branch of lienal artery.
14. Gastro-epiploica sinistra.
15. Superior mesenteric artery.
16. Inferior vena cava.
17. Portal vein.
18. Common hepatic duct.
19. Cystic duct.

The **Left Gastric Artery** (Gastric or coronary artery) (Fig. 24) passes upwards and to the left behind the omental bursa to the right side of the cardiac orifice of the stomach. Thence it changes its direction and passes along the lesser curvature of

the stomach to anastomose with the right gastric branch of the hepatic artery. Its branches are :—(1) *œsophageal*, which are two or three in number and ascend through the œsophageal opening of the diaphragm to anastomose with the œsophageal branches of the thoracic aorta ; (2) *cardiac*, which are distributed to the cardiac end of the stomach and anastomose with the short gastric branches of the lienal artery ; (3) *gastric*, which arise at the lesser curvature of the stomach and supply both surfaces of the viscus.

The vein accompanying the left gastric artery, called the *coronary vein*, passes along the lesser curvature of the stomach. Reaching the cœliac artery it passes to the right to open into the portal vein.

The **Hepatic Artery** (Fig. 24) is intermediate in size between the left gastric and the lienal arteries. It passes forwards and to the right along the superior border of the pancreas to the pylorus and forms the lower boundary of the epiploic foramen. Then it ascends between the two layers of the lesser omentum forming the anterior boundary of the same foramen. Here it lies to the left of the bile-duct. Near the porta of the liver it divides into two terminal branches, the right and left hepatic arteries. It is accompanied by a plexus of nerve fibres prolonged from the cœliac plexus. The branches of the hepatic artery are :—(1) The *right gastric* (pyloric) which arises near the pylorus and passes to the left along the lesser curvature of the stomach between the layers of the lesser omentum. It anastomoses with the left gastric artery and gives branches to both surfaces of the stomach. Its companion vein opens into the portal vein. (2) The *gastro-duodenal artery* which descends behind the first part of the duodenum and at its lower border divides into the *right gastro-epiploic* and the *superior pancreatico-duodenal* branches. The former runs from the right to the left along the greater curvature of the stomach and anastomoses with the left gastro-epiploic branch of the lienal artery. It gives branches to both surfaces of the stomach above and to the greater omentum below. The superior pancreatico-duodenal branch descends between the head of the pancreas and the duodenum, supplies both these organs and anastomoses with the inferior pancreatico-duodenal branch of the superior mesenteric artery. The right gastro-epiploic and the pancreatico-duodenal veins open into the superior mesenteric vein. (3) The *right hepatic artery* is one of the terminal branches and supplies the right lobe of the liver.

It gives off the *cystic branch* which supplies the gall-bladder. The cystic vein opens into the portal vein. (4) The *left hepatic artery* supplies the left lobe of the liver.

The **Lienal Artery** (Splenic artery) (Fig. 24) is the largest of the three branches of the cœliac artery and is conspicuous for its tortuous course. It passes to the left along the superior border of the pancreas, crosses the upper end of the left kidney and divides into several branches which enter the hilum of the spleen. It is surrounded by a plexus of nerve filaments derived from the cœliac plexus. The *lienal vein* lies on a lower level than the companion artery and is placed behind the pancreas; it joins the superior mesenteric vein to form the portal vein. The branches of the lienal artery are :—(1) The *pancreatic branches* which arise at intervals along the superior border of the pancreas and enter the gland. One of the branches is larger than the others and arises near the tail of the pancreas. This is called the *pancreatica magna branch*; it passes from the left to the right in the substance of the pancreas. (2) The *short gastric branches* (vasa brevia), five to seven in number, arise from the lienal artery or from its terminal branches. They pass to the right between the two layers of the gastro-lienal ligament and supply the cardiac end of the stomach, anastomosing with the branches of the left gastric and the left gastro-epiploic artery. (3) The *left gastro-epiploic artery* is directed from left to right along the greater curvature of the stomach and anastomoses with the right gastro-epiploic artery. It gives off ascending branches which supply both surfaces of the stomach and descending branches which supply the greater omentum (4) The *terminal branches* of the lienal artery enter the hilum of the spleen.

The **Lienal** or **Splenic vein** receives tributaries corresponding to the branches of the artery. In addition it receives the inferior mesenteric vein. It passes from left to right along the upper part of the posterior surface of the pancreas much below the companion artery and ends behind the neck of the gland by joining the superior mesenteric vein to form the portal vein.

Dissection. The veins which enter into the formation of the portal vein should now be fully displayed and for this purpose the pancreas is to be raised up and fixed with chain-hooks.

Portal Vein. (Fig. 25).—The portal system of veins includes all the veins which carry the blood from the abdominal portion of the alimentary canal, except the anal canal, and from the spleen, pancreas and gall-bladder. From all these viscera

the blood is carried to the liver by the portal vein. It is formed behind the neck of the pancreas and in front of the inferior vena-cava by the junction of the superior mesenteric and lienal veins. It is about three inches in length and passes upwards behind the first part of the duodenum and then between the two layers of the lesser omentum. Here it lies behind and between the bile duct and the hepatic artery and forms the anterior boundary of the epiploic foramen. On reaching the right end of the porta hepatis it divides into a right branch and a left branch. The right branch receives the cystic vein and ramifies in the right lobe of the liver. The left branch crosses the left sagittal fossa of the liver and in this fossa it is joined by para-umbilical veins and by the ligamentum teres in front and by the ligamentum venosum behind. The para-umbilical veins are seen along the ligamentum teres of the liver ; they establish communication at the umbilicus between the veins of the anterior abdominal wall and the portal vein. The left branch then ramifies in the left lobe of the liver. The tributaries of the portal vein are (1) lienal vein, (2) superior mesenteric vein, (3) coronary vein, (4) right gastric vein, (5) cystic vein, (6) para-umbilical veins.

Directions. The student should next proceed to the examination of the duodenum and the pancreas. He should inflate the stomach and the duodenum from the cut end of the latter viscus. The stomach is to be lifted well upwards and the pancreas to be traced from the duodenum to the spleen. While lifting the stomach he should avail himself of the opportunity presented for examining the *stomach bed* (p. 43).

The **Duodenum** (Figs. 25, 26), from its commencement at the pyloric end of the stomach to its termination at the duodeno-jejunal flexure, describes a curve resembling somewhat the shape of a horse-shoe. The concavity of the curve embraces the head of the pancreas. It is divisible into four portions, viz., (1) superior or first portion, (2) descending or second portion, (3) horizontal or third portion, and (4) ascending or fourth portion.

The *superior portion* is about two inches long and is free and movable like the stomach. It passes upwards and backwards to the neck of the gall-bladder. Its first half is entirely covered by peritoneum. Its terminal half is only covered by peritoneum in front and superiorly. *Above* it are the under surface of the liver and gall-bladder. *Below* it lies the pancreas (head and neck).

VII

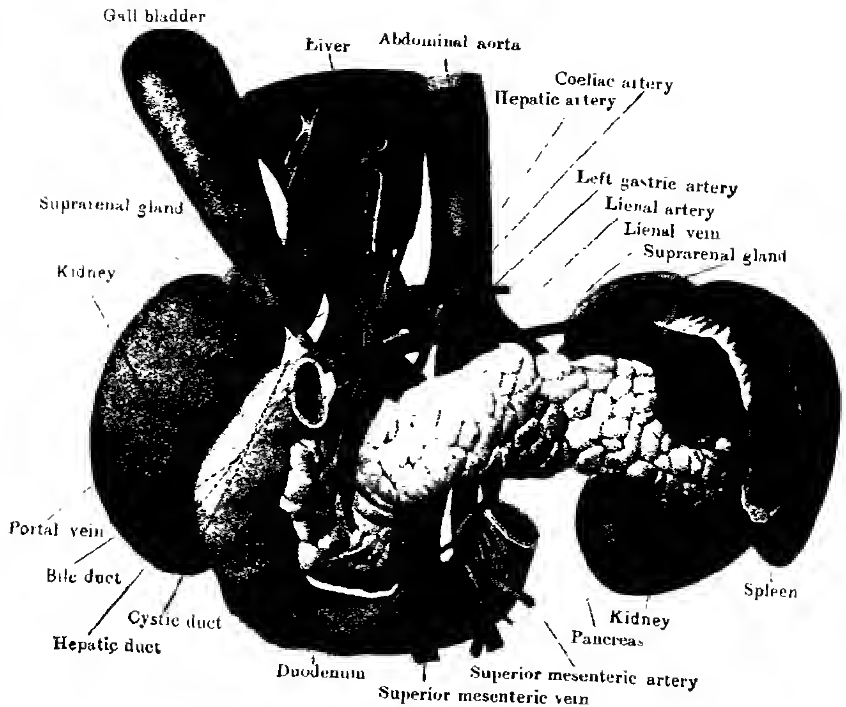

Fig. 25.—Duodenum, pancreas, portion of liver, spleen and kidneys (Sobotta).

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Behind it are the portal vein, the bile-duct and the gastroduodenal artery.

The *descending portion* is three to four inches long and is fixed immovably. It descends from the neck of the gall-bladder along the right side of the vertebral column to the right side of the third lumbar vertebra, where it terminates in the horizontal portion. *Anteriorly* it is covered by peritoneum except over its middle part where it is connected with the transverse colon by loose areolar tissue. *Posteriorly* it lies on the kidney, renal vessels and the inferior vena cava. *Medially* are found the head of the pancreas, the bile-duct and the pancreatico-duodenal arteries. *Laterally* is the right flexure of the colon. The pancreatic duct and the bile-duct open into this part of the duodenum at about its middle, piercing its wall at the medial and back part.

The *horizontal portion* is about three inches long. It begins on the right side of the third lumbar vertebra at its lower part and crosses to the left horizontally with a slight inclination upwards. It terminates in front of the abdominal aorta. It is covered by peritoneum in front only. *In front* are the superior mesenteric vessels ; behind it are the aorta, the inferior vena cava and the crura of the diaphragm. *Above* it are the superior mesenteric vessels and the pancreas.

The *ascending portion* is about one inch long. It ascends along the left side of the aorta to the level of the upper border of the second lumbar vertebra. Then it turns forwards to terminate in the jejunum forming the *duodeno-jejunal flexure*. It is covered in front and on its left side by peritoneum. The duodeno-jejunal flexure is held up in position by a band of plain muscular fibres which stretches from the flexure to the right crus of the diaphragm. This band is called the *musculus suspensorius duodeni*.

The **Pancreas** (Figs. 25, 26) extends transversely in the epigastric and left hypochondriac regions of the abdominal cavity. It presents for examination a head, a neck, a body and a tail. The *head* is flattened and is embraced by the concavity of the duodenum. It lies upon the aorta, the inferior vena cava, and the bile duct. Inferiorly the head is prolonged to the left as a hook-like process called the *uncinate process* which is crossed by the superior mesenteric vessels. The *neck* is the constricted portion which connects the head to the body and begins from the anterior surface of the upper part of the head. *Above* the

neck at its right end is a groove for the gastro-duodenal artery ; *below* it the superior mesenteric vessels emerge ; and *behind* it

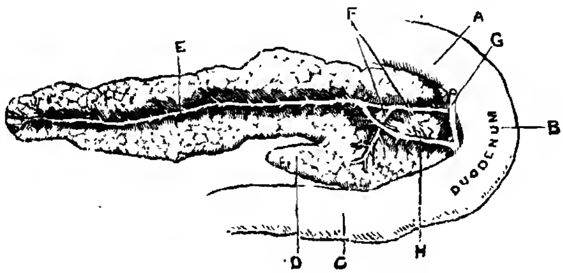

Fig. 26.—The pancreas and its ducts (posterior view). (After Buchanan).

A. Superior portion of duodenum.
B. Descending portion of duodenum.
C. Horizontal portion of duodenum.
D. Uncinate process.
E. Pancreatic duct.
F. Accessory pancreatic duct.
G. Bile duct.
H. Pancreatic duct.

is the commencement of the portal vein. The *body* has three surfaces and three borders. The *anterior surface* is concave, directed forwards and upwards and lies in contact with the postero-inferior surface of the stomach, separated from it by the omental bursa. Projecting upwards from the right side of this surface is an eminence called the *tuber omentale* which lies under cover of the lesser omentum The *posterior surface* is in relation with the aorta, the origin of the superior mesenteric artery, the left kidney, the left supra-renal gland, and the lienal vein The *inferior surface* is covered by peritoneum and rests on the duodeno-jejunal flexure, the coils of the jejunum and the left flexure of the colon. The *superior border* is in relation with the hepatic artery on the right side, and the lienal artery on the left side. The *anterior border* gives attachment to the transverse mesocolon, which splits into an ascending and a descending layer along this border. The *inferior border* lies at the junction of the posterior and inferior surfaces. The *tail* of the pancreas lies against the lower part of the gastric surface of the spleen.

The *pancreatic ducts* are two in number. The *main pancreatic duct* (duct of Wirsung) begins at the tail and proceeds towards the head. Divide the gland horizontally nearer the lower than the upper border ; the duct is recognised by its whiteness and is seen to be embedded in the substance of the gland. In its course to the head it receives several branches from the lobules of the

gland and becomes considerably increased in size. On reaching the head of the gland it passes downwards, backwards and to the right. While coming out of the head of the pancreas it is accompanied by the bile-duct. Both pierce the wall of the duodenum, unite and form a dilatation called the *ampulla of Vater,* which finally opens into the descending portion of the duodenum at the summit of an elevation called the *duodenal papilla* by a minute orifice. The *accessory pancreatic duct* (duct of Santorini) begins in the lower part of the head and passes upwards and gives off a branch which joins the main duct. Reaching the upper part of the head it opens into the descending part of the duodenum usually by a separate opening about three-fourths of an inch above the opening of the main duct.

Bile ducts (Fig. 25).—Leaving the porta hepatis are two ducts one coming from the right lobe called the *right hepatic duct,* and the other coming from the left lobe called the *left hepatic duct.* These two unite to form one duct called the *common hepatic duct,* which descends for nearly about an inch and is joined by the *cystic duct* from the gall-bladder to form the *bile-duct* or *ductus choledochus* (common bile-duct). The bile-duct is about 3 inches (7 cm.) long and of the diameter of a goose quill. It descends between the two layers of the lesser omentum at its free margin forming the anterior boundary of the epiploic foramen. Then it passes behind the superior portion of the duodenum and the head of the pancreas to the medial side of the descending portion of the duodenum. Here it pierces the wall of the duodenum obliquely and is joined by the main duct of the pancreas. The united ducts present a dilatation called the *ampulla of Vater* which opens by a narrow opening into the summit of the duodenal papilla.

Vagus Nerves.—These two nerves should now be traced. They enter the abdomen through the œsophageal opening of the diaphragm. Trace the left vagus nerve from the anterior aspect of the œsophagus. It will be found to supply the antero-superior surface of the stomach and to send filaments to the hepatic plexus between the two layers of the lesser omentum. The right vagus nerve will be found to lie behind the œsophagus and to distribute branches to the postero-inferior surface of the stomach. It sends filaments to the sympathetic plexus around the cœliac artery.

Dissection. Removal of the stomach, duodenum, pancreas, spleen and liver.—The stomach, the duodenum, the pancreas,

the spleen, and the liver should now be removed from the abdominal cavity. Divide the vessels and peritoneal folds which hold these organs in situ. In removing the liver first note the ligamentum teres which extends from the umbilicus along the free margin of the falciform ligament to the liver. Next examine the *falciform ligament.* It is a sickle-shaped fold of peritoneum having its anterior border attached to the diaphragm and the anterior abdominal wall. Its posterior border is attached to the anterior and superior surfaces of the liver. Its apex is directed upwards and backwards. Its base is free and encloses the ligamentum teres. Divide the ligamentum teres and the falciform ligament. Pass your hand along the superior surface of the liver till it meets with resistance. Here the peritoneum is reflected from the superior surface of the liver on to the diaphragm. The right extremity of this reflection forms the superior layer of the right triangular ligament of the liver. The central part of the reflection forms the superior layer of the coronary ligament and the left extremity forms the superior layer of the left triangular ligament of the liver. Then cut through this layer of peritoneum which forms the superior layer of the right and left triangular ligaments and of the coronary ligament, and draw the liver downwards. Between the two layers of the coronary ligament, the posterior surface of the liver is attached to the diaphragm by areolar tissue. This portion is to be separated by introducing the fingers. Notice the inferior vena cava emerging from the liver and piercing the central tendon of the diaphragm. Divide this vessel. The inferior layer of the right triangular, coronary, and left triangular ligaments is now seen. It is formed by the reflection of peritoneum from the lower part of the posterior surface of the liver on to the diaphragm. Divide this layer of peritoneum. Next divide the inferior vena cava again for the second time as it enters the liver from below. Divide the bile duct, portal vein and hepatic artery. The liver is now free from all connections, and note that as it is removed a portion of the inferior vena cava is taken away with it.

The **Liver** (Figs. 24, 27) is the largest gland in the human body. It measures transversely from 8 to 10 inches, antero-posteriorly about six inches and its greatest thickness is about six inches. It weighs about 3 to 4 lbs.

Surfaces.—(1) The *superior surface* is convex and is in relation with the under surface of the diaphragm. In the centre is a shallow depression called the *impressio cardiaca* corresponding to the

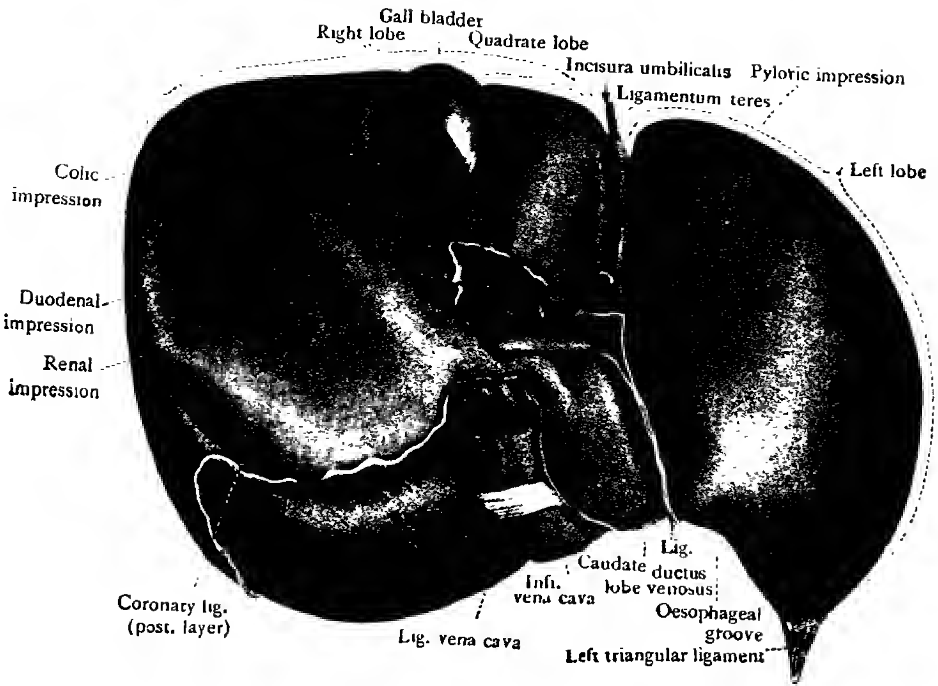

Fig. 27.—The inferior and posterior surfaces of the liver (Sobotta).

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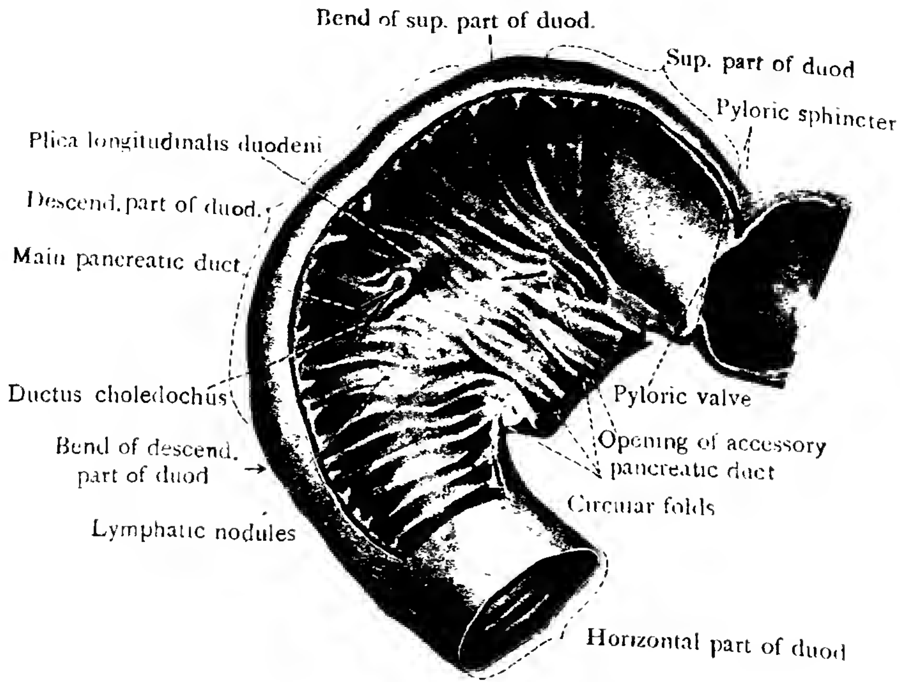

Fig. 29.—The interior of the duodenum (Sobotta).

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position of the heart on the upper surface of the diaphragm. The attachment of the falciform ligament subdivides this surface into a large right lobe and a small left lobe. It is not sharply demarcated from other surfaces. In well hardened specimens slightly rounded elevations are seen at the boundary lines. It is covered by peritoneum except at the line of attachment of the falciform ligament.

(2) The *anterior surface* is triangular and is in contact with the diaphragm and anterior abdominal wall. It is subdivided by the falciform ligament into a large right lobe and a small left lobe.

(3) The *right lateral surface* is convex and is in contact with the right portion of the diaphragm. It is separated from the anterior, superior and posterior surfaces by indistinct borders.

(4) The *inferior surface* is concave and is directed downwards, backwards and to the left. It is in relation with the stomach, the duodenum, the right colic flexure and the right kidney. It is subdivided into a right and a left lobe by the umbilical fissure containing the ligamentum teres. The inferior surface of the left lobe presents to the left and behind, the *gastric impression* for the antero-superior surface of the stomach. To its right is a rounded eminence called the *tuber omentale* which lies in contact with the lesser omentum. The inferior surface of the right lobe is subdivided into two portions by the cystic fossa which lodges the gall-bladder. The portion of the liver which lies to the left of the cystic fossa between it and the umbilical fissure, is the *quadrate lobe* which is limited in front by the anterior border of the organ and behind by the porta hepatis. The quadrate lobe lies in contact with the pyloric end of the stomach and the superior portion of the duodenum. The *porta hepatis* (transverse fissure) extends from the back part of the umbilical fissure towards the right to the back part of the cystic fossa. Through it the portal vein, the hepatic ducts and the hepatic artery pass. Behind the porta hepatis is the *caudate lobe*, the lower end of which is seen on the inferior surface. It is bounded on the right side by the fossa for inferior vena cava and on the left side by the fossa for ductus venosus. The caudate lobe presents on its right side an elongated elevation by which it is connected with the remaining part of the inferior surface of the right lobe. This is called the *caudate process*. The left side of the caudate lobe presents a projection called the *papillary process*. The inferior surface of the right lobe to the right side of the cystic

fossa presents three impressions :—(*a*) the *colic impression* in front for the right flexure of the colon, (*b*) the *renal impression* behind for the right kidney, and (*c*) the *duodenal impression* which lies between the renal impression and the neck of the gall-bladder, and is produced by the descending portion of the duodenum.

(5) The *posterior surface* is somewhat rounded. It is broader on the right lobe than on the left, where it is reduced to a border. Commencing from the left the student will see :—(i) the *impression for the œsophagus.* (ii) The *fossa for the ductus venosus* which lies to the right of the œsophageal groove and to the left of the caudate lobe. Inferiorly it meets the umbilical fissure and superiorly the fossa for inferior vena cava. It lodges the remains of the ductus venosus. (iii) The *caudate lobe* which lies vertically. Its lower end projects into the inferior surface. It is bounded on the left by the fossa for the ductus venosus, on the right by the fossa for the inferior vena cava and below by the porta hepatis. (iv) The *fossa for the inferior vena cava* which lies vertically to the right of the caudate lobe. It is a deep fossa and lodges the inferior vena cava. It is sometimes bridged over by liver tissue called *pons hepatis.* (v) The *"bare area"* which lies to the right of the caval fossa and is destitute of peritoneum. It lies between the two layers of the coronary ligament and is attached to the diaphragm by areolar tissue. (vi) Towards the left end of the "bare area" near the caval fossa is a triangular impression, called the *suprarenal impression,* for the right suprarenal gland.

The **Gall-Bladder** (Fig. 27) is a pear-shaped bag, situated on the under surface of the liver in the cystic fossa extending from the anterior border of the liver to the right end of the porta hepatis. It presents for examination a fundus, a body and a neck. The *fundus* is the dilated anterior end which projects beyond the anterior border of the liver. It is entirely covered by peritoneum. The *body* has its upper surface attached to the cystic fossa by areolar tissue ; its under surface is covered by peritoneum and is in relation with the duodenum and the transverse colon. The *neck* is the constricted portion which joins the cystic duct. This duct is about an inch and a half long and passes downwards, backwards and to the left to join the common hepatic duct forming the bile duct.

Structure of the gall-bladder and cystic duct.—Open the gall-bladder and the cystic duct. Note that the mucous membrane

of the neck of the gall-bladder and the cystic duct is thrown into folds running in a spiral manner around the lumen. In the gall-bladder the mucous membrane is thrown into ridges with intervening depressions. Muscular and fibrous tissue form the framework of the sac. The serous or peritoneal covering has been already referred to.

The structures at the porta hepatis should now be traced into the substance of the liver for a little distance. These are the portal vein, the hepatic artery and the bile duct and have the following positions: the duct on the right side, the artery on the left, and the vein behind and between them. Note that the ramifications of the portal vein, the hepatic artery and the hepatic duct accompany each other and are bound together by a fibrous sheath called *Glisson's capsule.* The channel in the liver substance containing a branch of the portal vein, a branch of the hepatic artery, a branch of the hepatic duct and lymphatic vessels, all bound together by Glisson's capsule, is called a *portal canal.* Cut a slice of the liver and examine its surface. The dissector will identify the portal canal by the presence of white strands of fibrous tissue (Glisson's capsule) closing the cut ends of a branch of portal vein, of hepatic artery, and of hepatic duct. On this section other cut channels with gaping mouths will be seen. These are the cut ends of the hepatic veins. They are isolated channels and are not accompanied by any other vessel. These hepatic veins are embedded in the substance of the liver and pass towards the fossa for the inferior vena cava. Open the portion of the inferior vena cava lying in its fossa and note the terminations of the hepatic veins in it. It should be understood that the hepatic veins are altogether embedded in the liver substance and that throughout their entire course, from their origin in the intralobular veins to their terminations into the inferior vena cava as it lies in the fossa of that organ, the hepatic veins have no course whatsoever outside the gland.

The **Lien** (Spleen) (Fig. 28) lies chiefly in the left hypochondriac region but extends also into the epigastric region. It is of a dark purple colour. It measures five inches (12.5 cm.) in length, three inches in breadth and one inch and a half in thickness. Its connections with the stomach by the gastro-lienal ligament and with the kidney by the phrenico-lienal ligament have been already noted. It presents for examination four borders and four surfaces. The borders are:—(1) The ***anterior border*** is thin and usually notched. (2) The ***posterior border*** is

rounded and thick and lies between the diaphragm and the left kidney. (3) The *inferior border* connects the lower ends of the anterior and posterior borders. (4) The *intermediate border* begins from the upper end of the spleen, bifurcates below and encloses a triangular surface the base of which is formed by the inferior border. The surfaces are :—(1) The *diaphragmatic surface* is convex and lies against the diaphragm opposite the ninth, tenth and eleventh ribs. (2) The *gastric surface* is deeply concave and lies between the anterior and intermediate borders. The fundus of the stomach lies against this surface. A little in front of the intermediate border is a longitudinal fissure called the *hilum* of the spleen through which

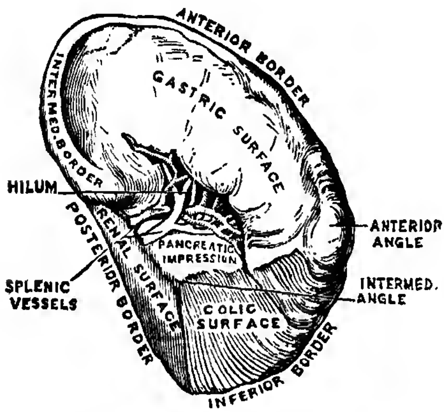

Fig. 28.—The spleen (after Buchanan).

the lienal vessels and nerves pass. In front of the lower end of the intermediate border is an impression called the *pancreatic impression* against which the tail of the pancreas lies. (3) The *renal surface* lies between the posterior and intermediate borders. It is concave and lies against the anterior surface of the left kidney. (4) The *colic surface* is triangular. It lies between the two bifurcated limbs of the intermediate border and the inferior border. This surface lies in contact with the left colic flexure. The *upper end* of the spleen is rounded and directed towards the vertebral column and the *lower end* is held by the phrenico-colic ligament.

Structure of the Spleen.—The spleen is covered externally by peritoneum which invests it completely except at the hilum. This is the *serous coat.* Beneath the serous coat is the *fibrous coat* which not only covers the surface of the organ but sends in processes, called *trabeculæ,* into its interior. Cut a portion of the spleen and squeeze it. When the soft reddish brown pulpy matter, called the *splenic pulp,* is squeezed out the trabecular framework will be seen.

The **Stomach** (Fig. 13) should now be inflated. Place one ligature round the superior portion of the duodenum and another above the cardiac orifice of the stomach. On the lesser curvature of the stomach nearer the pyloric end than the cardiac end is a notch called the *incisura angularis.* Opposite this notch there is a dilatation along the greater curvature of the stomach. This dilatation is called the *antrum pylori.* The portion of the stomach lying to the left of a line drawn from the incisura angularis to the left side of the pyloric antrum is called the *cardiac part* of the stomach, while the portion lying to the right side of the line is called the *pyloric part.* A line passing transversely through the lower margin of the cardiac orifice subdivides the cardiac portion into an upper part, called the *fundus* and a lower part called the *body.* Another notch, the *sulcus intermedius,* is seen on the greater curvature to the right side of the pyloric antrum. This notch divides the pyloric part into two portions: the *pyloric antrum,* which lies to the left and the *pyloric canal* which lies to the right. The constriction around the pyloric orifice is called the *duodeno-pyloric constriction* The stomach can therefore be described as consisting of four segments, viz., (1) fundus, (2) body, (3) pyloric antrum, (4) pyloric canal. The average length of the stomach measured between two farthest points at the fundal and pyloric ends is about eleven inches in the Hindus. The greatest width is about six inches. The average capacity in Hindus is much larger and ranges between seventy and eighty ounces (Journal of Anatomy Vol: LIII, Parts II and III, 1919).

Structure of the Stomach.—The wall of the stomach consists of four coats (1) serous, (2) muscular, (3) submucous, and (4) mucous. The *serous coat* is derived from the peritoneum which encloses the whole organ except along its greater and lesser curvatures where the vessels run. The *muscular coat* will be exposed by the removal of the serous coat; it consists of unstriped muscle fibres arranged in three strata. From without inwards they are:—(*a*) The *longitudinal layer.* It consists of fibres passing from the cardiac to the pyloric orifice. They are more developed at the curvature of the stomach. (*b*) The *circular layer.* It consists of fibres arranged circularly over the whole of the stomach. They are most numerous at the pyloric part. Opposite the duodeno-pyloric constriction they are thickened into a ring called the *pyloric sphincter.* (*c*) The *oblique layer.* It consists of fibres situated at the cardiac part of the stomach. Towards the right

they present a free margin. Remove the muscular coat from a portion of the stomach. The submucous coat is exposed ; it is composed of loose areolar tissue and supports the blood vessels prior to their ramification in the mucous membrane. The *mucous coat* is to be studied by opening the stomach along the lesser curvature. In a fresh specimen the mucous membrane is soft and of a pale rose colour. When well washed and examined with the aid of a lens, its surface is found to be covered with innumerable depressions specially near the pylorus ; at the bottom of each depression is seen the orifice of the gastric gland-tube. When the stomach is contracted the mucous membrane is thrown into a number of folds called *rugæ*, which for the most part have a longitudinal direction. These are temporary folds because they disappear during the distension of the organ. After the mucous membrane has been studied, it should be stripped off from the pyloric orifice to expose the *pyloric sphincter.* This sphincter is caused by a thickening of the circular muscle fibres, and here the deep muscle fibres of the longitudinal layer also end. This gives a hard feel to the pyloric end of the stomach. The projection into the interior caused by the sphincter and covered by mucous membrane is called the *pyloric valve.*

Duodenum.—The mucous membrane of the duodenum (Fig. 29) should now be examined by slitting open its descending portion along the right convex margin and extending the cut above and below. Notice the *aperture* common to the bile-duct and the main pancreatic duct, placed on a small elevation, the *duodenal papilla,* at the medial and back aspect of the descending portion of the duodenum. Pass a fine probe through this opening and cut down along the probe. The ampulla of Vater and the openings of the bile and pancreatic ducts will be seen. The *plicæ circulares* begin to appear near the commencement of the descending portion of the duodenum and they are very thickly set below the duodenal papilla. A large plica circularis overhangs the duodenal papilla like a cap and a prominent longitudinal fold called the *plica longitudinalis duodeni* usually descends from the papilla. The *duodenal glands* (Brunner's glands) are seen only in the duodenum and exist in large numbers in its descending portion.

Dissection. The sympathetic plexuses lying in the posterior abdominal wall and their prolongations may now be examined. Look for two large ganglia, the cœliac ganglia. The left cœliac ganglion is found to the left side of the cœliac artery and the right

cœliac ganglion to the right side of the artery under cover of the inferior vena cava.

The **Cœliac Plexus** (Solar plexus) is the largest of the three plexuses of the sympathetic which are seen in front of the vertebral column ; it is situated at the level of the first lumbar vertebra. It consists of a network of nerve fibres and ganglia which lie between the suprarenal glands and in front of the commencement of the abdominal aorta and crura of the diaphragm. It surrounds the origin of the cœliac artery. Of the ganglia the chief are the two *cœliac* or *semilunar ganglia,* one in each half of the plexus. These are the largest ganglia in the body. The right cœliac ganglion is placed beneath the inferior vena cava. Each ganglion is joined by the greater splanchnic nerve of the same side at its upper part while the lower part of the ganglion remains as a separate small ganglion, called the *aortico-renal ganglion,* and is joined by the lesser splanchnic nerve. The cœliac plexus gives off filaments which descend on the abdominal aorta and accompany the various branches of this arterial trunk. The following subsidiary plexuses are derived from the cœliac plexus :—

(1) The *phrenic plexus* accompanies the inferior phrenic branch of the abdominal aorta to the under surface of the diaphragm where it communicates with the phrenic nerve. On the right side a small ganglion called the *ganglion phrenicum* is seen at the point of communication.

(2) The *superior gastric plexus* accompanies the left gastric branch of the cœliac artery and has been noticed while tracing the artery.

(3) The *hepatic plexus* issues from the cœliac plexus, accompanies the hepatic artery to the liver and is also prolonged on the other branches of the hepatic artery. It is joined by filaments from the left vagus nerve. This plexus has been examined while tracing the hepatic artery. A prolongation of this plexus along the right gastro-epiploic branch of the gastro-duodenal artery along the greater curvature of the stomach is called the *inferior gastric plexus.*

(4) The *lienal* or *splenic plexus* accompanies the lienal artery to the spleen and distributes twigs along the various branches of the artery. It is joined by filaments from the right vagus nerve. It has been noticed during the dissection of the lienal artery.

(5) The *suprarenal plexus* gets fibres mostly from the cœliac ganglion as also from the cœliac plexus. It accompanies the middle suprarenal artery to the suprarenal gland. It is connected

above with the phrenic plexus and below with the renal plexus. A filament from the lowest splanchnic nerve usually joins this plexus and a small ganglion is seen at the point of this junction.

(6) The *renal plexus* derives its fibres from the cœliac ganglion, the cœliac and aortic plexuses. It accompanies the renal artery to the kidney and is joined by the lowest splanchnic nerve from above. A few small ganglia are found in this plexus. Filaments from it are given to the suprarenal plexus and to the spermatic or ovarian plexus.

(7) The *superior mesenteric plexus* is derived from the cœliac plexus. Its distribution with the branches of the superior mesenteric artery has been noted.

(8) The *abdominal aortic plexus* is placed upon the front and sides of the abdominal aorta between the origins of the superior and inferior mesenteric arteries. It derives its fibres from the cœliac and superior mesenteric plexuses and from the ganglia of the abdominal part of the sympathetic. It furnishes offshoots to the renal, the spermatic and the inferior mesenteric plexuses. It is continued downwards over the common iliac arteries to form the hypogastric plexuses.

(9) The *spermatic plexus* accompanies the testicular branch of the abdominal aorta to the testis. It derives its fibres from the aortic and renal plexuses. In the female the *ovarian plexus* accompanies the ovarian artery to the ovary.

(10) The *inferior mesenteric plexus* is derived from the aortic plexus. It accompanies the inferior mesenteric artery. Its distribution with the branches of the artery has been noted.

The student should now study the kidneys and suprarenal glands. Before cleaning the organ note that a loose fibrous sheath, called the renal fascia, invests it. The *renal fascia* consists of two layers, an anterior and a posterior. Traced medially the anterior layer passes in front of the kidney over the renal vessels and the abdominal aorta and becomes continuous with the corresponding layer of the opposite side. Traced laterally it blends with the posterior layer at the lateral border of the kidney. Traced upwards it covers the suprarenal gland, blends above that organ with the posterior layer and is continuous with the fascia covering the under surface of the diaphragm. Traced downwards it merges into the subperitoneal fascia of the iliac fossa. The posterior layer of the renal fascia passes medialwards behind the kidney and is blended with the fascia covering the quadratus lumborum and the psoas major. Below the kidney it does not

fuse with the anterior layer but is lost in the iliac fossa like the anterior layer.

Remove the renal fascia and clean the fatty tissue in which the kidney is embedded. This fatty tissue, called the *adipose capsule*, and the kidney are enclosed within the renal fascia. It is not to be confounded with the *fibrous capsule* which forms the immediate covering of the kidney and can be easily peeled off from the surface of the organ. Trabeculæ pass from the renal fascia to the fibrous capsule of the kidneys after traversing the adipose capsule. The pad of fatty tissue lying behind the renal fascia is called *paranephric fat.*

The **Kidneys** (Fig. 30) lie against the posterior abdominal wall, one on each side of the vertebral column and are placed opposite the last thoracic and the upper three lumbar vertebræ. The upper end of each kidney is nearer the vertebral column than the lower end. The upper end of the right kidney lies against the twelfth rib, while that of the left kidney lies against the lower border of the eleventh rib. The lower ends of the kidneys are about two inches above the iliac crest, that of the right side being a little

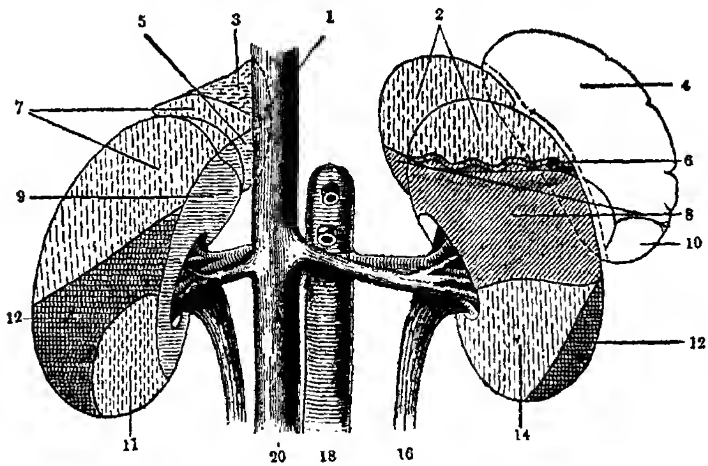

Fig. 30.—Diagram showing relations of kidneys, supra-renal glands and spleen (From Morris).

1. Caval area.
2. Gastric area (peritoneal).
3. Hepatic area (non-peritoneal).
4. Gastric area of spleen.
5. Duodenal area (non-peritoneal).
6. Splenic artery.
7. Hepatic area (peritoneal).
8. Pancreatic area (non-peritoneal).
9. Duodenal area (non-peritoneal).
10. Colic area of spleen.
11. Meso-colic area.
12. Colic area (non-peritoneal).
14. Meso-colic area.
16. Ureter.
18. Aorta.
20. Vena cava inferior.

lower. Their average length is about four inches (10 cm.), breadth about two inches and a half, and thickness a little more than an inch. Each kidney has a characteristic form and presents for examination two surfaces, two borders, and two ends.

The anterior surface of both kidneys is convex and looks forwards and lateralwards.

The *anterior surface of the right kidney* is covered by the right suprarenal gland close to the upper end of the organ. This portion is the *suprarenal area* and is non-peritoneal. Below this the lateral portion of the anterior surface presents the large *hepatic area* where the inferior surface of the liver lies in contact with it. This surface is peritoneal. Medial to this is the *duodenal area* close to the medial border of the kidney over which the second portion of the duodenum lies. This area is non-peritoneal. Below the hepatic area is the *colic area* over which the right flexure of the colon and the commencement of the transverse colon lies. This area is non-peritoneal. The extreme lower end of the anterior surface is usually covered by the coils of the small intestine.

The *anterior surface of the left kidney* presents at its upper end and upper portion of the medial border a narrow *suprarenal area* covered by the left suprarenal gland. This area is non-peritoneal. The *splenic area* is narrow and close to the lateral border of the organ at its upper part. This area is peritoneal and lies in contact with the renal surface of the spleen. Between the suprarenal and splenic areas is the triangular *gastric area* covered by peritoneum. The postero-inferior surface of the stomach lies over this area. Below the gastric area and covering the upper part of the hilum of the kidney is the quadrilateral *pancreatic area* which is non-peritoneal and lies in contact with the posterior surface of the pancreas. At the lower and lateral part of the anterior surface is the *colic area*, which is non-peritoneal and covered by the left flexure of the colon and the commencement of the descending colon. Between the colic and pancreatic areas is the *jejunal area* which is peritoneal and covered by the jejunum.

The *posterior surface of both kidneys* is less convex than anterior, is embedded in adipose tissue and has no *peritoneal covering*. It is in relation with the twelfth rib and the diaphragm above. Below that the psoas major muscle lies medially and the quadratus lumborum laterally. On the left side the eleventh rib also lies behind the upper end of the kidney.

Borders.—The lateral border is markedly convex. The

medial border is concave and presents a deep longitudinal fissure called the *hilum* which gives passage to the vessels and nerves of the kidney as also its duct called the ureter. The hilum is bounded by two thick lips, an anterior and a posterior, and leads into a cavity called the *renal sinus.* The relative positions of the structures at the hilum should be noted. The renal vein lies in front, the ureter behind, and the renal artery lies between the two. The *upper end* of the kidney is thick and broad. The *lower end* is thin and more pointed.

The student can easily distinguish between the right and left kidney by noticing the position of the ureter which is close to the posterior lip of the hilum and is inclined downwards.

The **Ureters** are two tubes which convey the urine from the kidneys to the bladder. Each ureter is about sixteen inches (40 cm.) in length ; it presents at the hilum of the kidney a funnel-shaped dilatation, the *pelvis of the ureter,* and is then continued downwards and medialwards as a cylindrical tube. It lies upon the psoas major muscle, crosses the common iliac or external iliac artery and enters the pelvis. It is covered by peritoneum. The right ureter passes into the pelvis behind the terminal part of the ileum while the left behind the sigmoid mesocolon. Both are crossed by the testicular vessels. The course of the ureters in the pelvis will be studied at a later stage.

Dissection. Remove one kidney with a portion of the ureter and renal vessels. Divide it into two halves by cutting through from the lateral to the medial border of the organ. Note that the ureter as it approaches the hilum of the kidney shows a funnel-shaped dilatation, called the *pelvis of the ureter.* In the renal sinus the pelvis divides into two or three branches. These again subdivide into several short branches called *calyces* or *infundibula.*

General structure of the kidney (Fig. 31).—From the cut lateral margin of the kidney strip off the *fibrous capsule* and reflect it towards the hilum. Note that at the renal sinus the fibrous capsule becomes continuous with the wall of the pelvis of the ureter. The proper substance of the kidney consists of a peripheral portion, which is pale and granular, called the *cortical portion,* and of a central portion which is dark coloured, called the *medullary portion.* In the medullary portion a number of (six to eighteen) dark conical masses are seen called the *renal pyramids.* The bases of the pyramids are directed towards the cortical portion and their apices called the *renal papillæ* are embraced by the calyces. One or more papillæ may be thus embraced by one calyx. The

cortical substance is prolonged between the pyramids forming the *renal columns* (columns of Bertini) and through these columns the renal vessels are seen as they pass. Along the bases of some of the pyramids arterial arches may be seen.

The student has noted three capsules in connection with the kidney. From without inwards they are: (1) the renal fascia, (2) the fatty or adipose capsule and (3) the fibrous capsule.

The **Suprarenal Glands** (Figs. 32,33) are two small bodies situated on the upper ends of the kidneys encroaching slightly on their anterior surfaces and medial borders.

The *right suprarenal gland* is triangular in shape. Its *anterior surface* presents a lateral triangular area which lies against the posterior surface of the liver and a medial narrow area covered by the inferior vena cava. At the upper part of this medial area is a small fissure, called the *hilum*, through which the right suprarenal vein emerges. The *posterior surface* lies against the diaphragm by its upper part. By its lower part which is concave it lies over the right kidney.

The *left suprarenal gland* is semilunar in shape. Its medial border is convex and lateral border concave. Its *anterior surface* at the upper part is covered by the stomach being separated from that viscus by the omental bursa. At its lower part it is covered by the pancreas and the lienal artery. The *hilum* through which the left suprarenal vein emerges is situated at the lower and medial part of this surface. The *posterior surface* is subdivided into two areas, medial and lateral, by a ridge; the medial area is flat and rests against the left crus of the diaphragm; the lateral area is deeply concave and lies against the medial border and upper end of the left kidney.

General Structure.—The suprarenal gland is enclosed by a fibrous capsule which sends processes into its interior. On section, it is seen to consist of an external firm part, the *cortex* and of an internal pulpy part, the *medulla*.

Dissection. The diaphragm should now be studied. Remove the peritoneum from its abdominal surface and clean the muscular fibres, the crura and the central tendon, taking care of the vessels and nerves which ramify upon this surface of the muscle.

The **Diaphragm** (Fig. 34) is a musculo-tendinous arch which forms the movable partition between the thoracic and abdominal cavities. It forms the convex floor of the thorax and the concave roof of the abdomen. Its circumferential portion is

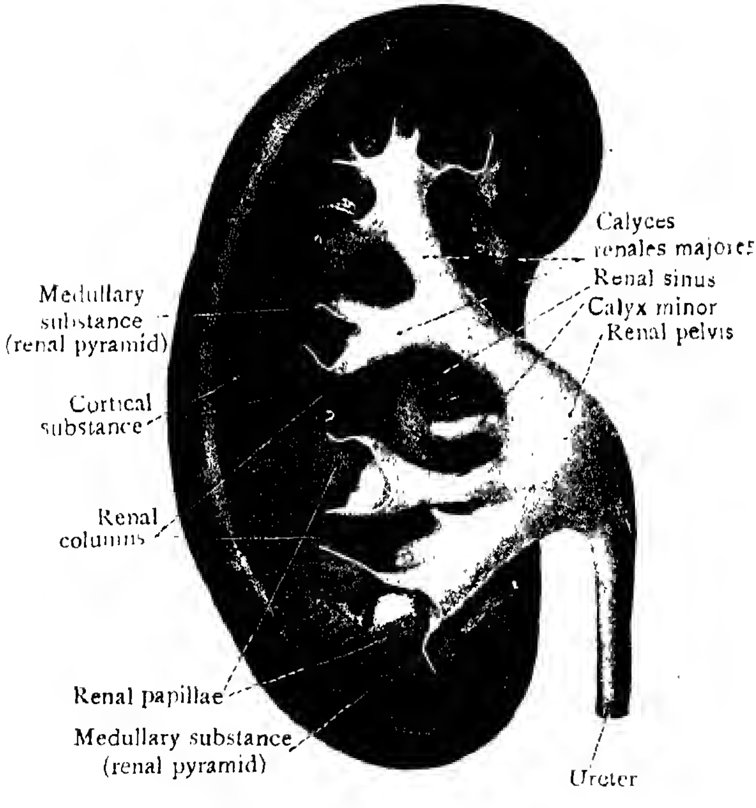

Fig 31.—Vertical section through a kidney (Sobotta).

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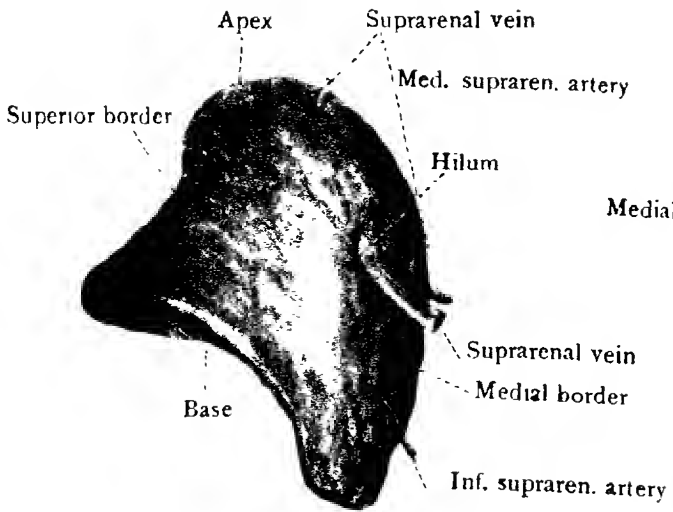

Fig. 32.—The right suprarenal gland.

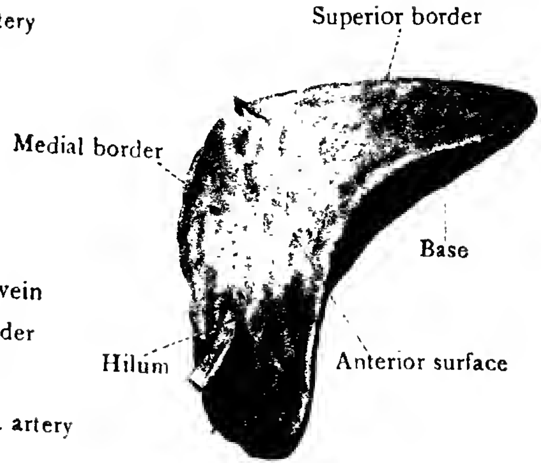

Fig. 33.—The left suprarenal gland.

muscular which takes origin from the xiphoid process, the surrounding ribs and vertebral column; its central portion which constitutes the insertion, is tendinous. The origin of the muscular fibres may be divided into three parts: the sternal, costal and lumbar. The sternal portion arises from the posterior surface of the xiphoid process by two fleshy slips. The costal portion arises from the inner surface of the cartilages of the lower six ribs on either side interdigitating with the transversus abdominis. The lumbar portion arises from the lateral lumbocostal arch, from the medial lumbocostal arch and from the bodies of the upper two or three lumbar vertebræ by two crura.

Fig 34.—Abdominal surface of the diaphragm.

A. Right leaflet
B. Left leaflet
C. Central leaflet.
D. Right crus.
E. Left crus.
F. Lateral lumbo-costal arch.
G. Medial lumbo costal arch:
H. Aortic opening.
I. Œsophageal opening.
J. Vena caval opening.
L. Fourth lumbar vertebra.
M. Psoas major.
N. Quadratus lumborum.
G. Tip of last rib.

The *lateral lumbocostal arch* (External arcuate ligament) is the thickened and arched upper part of the fascia covering the quadratus lumborum. It is attached medially to the transverse process of the first lumbar vertebra and laterally to the tip and lower border of the twelfth rib.

The *medial lumbocostal arch* (Internal arcuate ligament) is the thickened and arched upper part of the fascia covering the psoas major. It extends from the side of the body of the second lumbar

vertebra and the tendinous crus of the diaphragm to the tip of the transverse process of the first lumbar vertebra.

The *crura* of the diaphragm are two in number. The right crus is larger and longer and arises by tendinous fibres from the anterior surfaces of the bodies of the upper three lumbar vertebræ and the intervertebral fibro-cartilages lying between them. The attachment of the left crus does not descend below the second lumbar vertebra. Where the aorta enters the abdomen the medial tendinous margins of the two crura are united together by a tendinous arch in front of the aorta.

From these sources of origin all the fibres of the muscle converge to be inserted into the *central tendon*. The slips originating from the xiphoid process are short and are separated from the muscle fibres originating from the costal cartilages by a cellular interval and hence no muscle fibres intervene between the pleural sac above and the peritoneal sac below at this situation. The muscle fibres arising from each crus separate into two bundles, a lateral and a medial. The lateral bundles diverge from each other and are inserted into the central tendon. The medial bundles of the two sides decussate in front of the aortic and behind the œsophageal opening before being inserted into the central tendon.

The **Central Tendon of the Diaphragm** is the expanded tendinous part in the centre and is placed below the pericardium with which it is blended. It resembles a trefoil leaf in shape consisting of three leaflets. The right leaflet is the largest, the left the smallest, and the middle intermediate in size.

Openings in the Diaphragm.—There are three large and several small openings in the diaphragm. The three *large openings* are:—(1) The *aortic opening* which is osseoaponeurotic, and bounded in front by the fibrous arch which connects the medial margins of the two crura and behind by the body of the first lumbar vertebra. It gives passage to the aorta, the thoracic duct and the azygos vein. (2) The *œsophageal opening* is oval in shape and placed in the muscular part of the diaphragm, lying above, in front and to the left of the aortic opening. It is situated opposite the tenth thoracic vertebra. Behind it are the decussating medial bundles from the two crura. It gives passage to the œsophagus, the vagus nerves, and some œsophageal vessels. (3) The *vena caval opening* is the highest of the three, quadrilateral in shape, and situated at the junction of the right and middle leaflets and entirely tendinous. It is situated opposite the fibrocartilage

between the eight and ninth thoracic vertebræ. It transmits the inferior vena cava and some filaments of the right phrenic nerve. *Small openings.*—The right crus is perforated by the three splanchnic nerves and the left crus transmits, in addition, the hemiazygos vein. The superior epigastric artery passes in the interval between the sternal and costal origins of the diaphragm. The musculo-phrenic artery pierces the costal origin of the diaphragm opposite the eighth or ninth rib.

Relations.—The *upper surface* of the diaphragm is in relation with the base of the lung on either side, the pleura intervening between the two ; its central tendon, with the heart, the pericardium intervening between the two. The *under surface* of the diaphragm is covered for the most part by the peritoneum ; its right side is in contact with the right lobe of the liver, right kidney and right suprarenal gland, its left side with the left lobe of the liver, the fundus of the stomach, the spleen, the left kidney and the left suprarenal gland.

Nerve supply.—The diaphragm is supplied by the phrenic and lower six intercostal nerves. *Arterial supply.*—On the under surface of the diaphragm are the two inferior phrenic arteries (p. 89), the musculo-phrenic artery which supplies the upper costal slips of the diaphragm, and the superior epigastric artery which ramifies over the middle of the muscle. The last two arteries are branches of the internal mammary artery. *Actions.*—The diaphragm is the chief muscle of inspiration. When the circumferential muscle fibres contract the central tendon is lowered pushing down the abdominal viscera and thus increasing the vertical diameter of the thoracic cavity. As soon as the descent of the central tendon is checked the lower ribs are elevated and the sternum is thrown forwards.

VESSELS ON THE POSTERIOR ABDOMINAL WALL

Dissection. The dissection of the vessels of the posterior abdominal wall should now engage the attention of the student. The abdominal aorta and those of its branches which have not been studied are now to be cleaned. When cleaning the lumbar branches of the aorta which pass lateralwards behind the sympathetic trunk, care should be taken not to injure this trunk. The cisterna chyli together with the commencement of the thoracic duct and the azygos vein are to be looked for in the space between the aorta and the right crus of the diaphragm. The inferior

vena cava is to be cleaned and its tributaries traced. Numerous lymph glands are seen on either side of the aorta and inferior vena cava ; some of these ought to be preserved.

The **Abdominal Aorta** (Fig. 35) extends from the lower border of the twelfth thoracic vertebra at the aortic opening of the diaphragm to the level of the body of the fourth lumbar vertebra a little to the left of which it divides into the two common iliac arteries. It runs an oblique course for it begins in the median line and ends a little to the left of the median line. Its termination takes place opposite a point below and slightly to the left of the umbilicus and on a level with the highest point of the iliac crest. The coils of small intestine, the great omentum, the transverse colon, the liver, the stomach and the lesser omentum which covered the artery superficially have all been removed. The structures which are in direct relation with it are in *front* the cœliac plexus, the lienal vein, the pancreas, the left renal vein, the third part of the duodenum, the mesentery proper, the aortic plexus and some lymph glands (*preaortic*). *Behind* it are the bodies and intervertebral discs of the lumbar vertebræ, the anterior longitudinal ligament and the left lumbar veins. To its *right side* are the azygos vein, the cisterna chyli, the thoracic duct, the right crus of the diaphragm and the inferior vena cava. To its *left side* are the left crus of the diaphragm, the left cœliac ganglion and the ascending part of the duodenum. On either side of the aorta are many lymph glands called *lateral aortic lymph glands*.

The **Branches of the Abdominal Aorta** arise in the following order :—First are the two inferior phrenic arteries which issue from the front of the aorta immediately it enters the abdominal cavity ; next is the single trunk of the cœliac artery ; about a quarter of an inch lower down is the trunk of the superior mesenteric artery ; at the same level as the superior mesenteric are the two middle suprarenal arteries, one from each side of the aorta ; half an inch lower down the right and left renal arteries arise from the sides of the aorta ; below the renal are the two testicular or ovarian arteries, arising from the front of the aorta ; about two inches above the bifurcation of the aorta, the trunk of the inferior mesenteric artery issues ; the lumbar arteries, four in number, on either side, arise from opposite the upper four lumbar vertebræ ; and lastly the single middle sacral artery takes origin from the back part of the aorta a little above its bifurcation.

The branches of the abdominal aorta may be classified into

three sets: (1) the terminal—these are the two common iliac arteries; (2) the parietal—these are the inferior phrenic, lumbar and middle sacral; (3) the visceral—these are the remaining branches and supply the abdominal viscera. Of these the cœliac, the superior mesenteric and the inferior mesenteric arteries have been studied. The remaining branches are now to be examined.

The **Inferior Phrenic Arteries,** two in number, arise from the abdominal aorta just below the diaphragm above the origin of the cœliac artery and run upwards and lateralwards to the under surface of the diaphragm. The left phrenic artery passes behind the œsophagus while the right artery passed behind the the inferior vena cava. Each phrenic artery gives off the *superior suprarenal artery* which supplies the suprarenal gland. At the posterior border of the central tendon each vessel divides into a medial and a lateral branch. The *medial branch* passes forwards and anastomoses with its fellow of the opposite side and with the musculophrenic artery. The *lateral branch* passes towards the side of the thorax and anastomoses with the musculophrenic and lower intercostal arteries. The *inferior phrenic vein* terminates in the inferior vena cava.

The **Middle Suprarenal Arteries** (Middle capsular arteries), two in number, arise from the abdominal aorta on either side opposite the origin of the superior mesenteric artery. They pass lateralwards and slighty upwards to the suprarenal gland and anastomose with the suprarenal branches of the inferior phrenic artery above and renal artery below. The right *suprarenal vein* terminates in the inferior vena cava, but the left one terminates either in the left renal or inferior phrenic vein.

The **Renal Arteries** are two short thick branches which arise from the abdominal aorta just below the origin of the superior mesenteric artery. Each artery passes lateralwards to the hilum of the kidney. The right one is longer than the left and passes behind the inferior vena cava. Before entering the hilum of the kidney each artery divides into three or four branches which lie between the renal vein in front and the ureter behind. These branches enter the substance of the kidney along the renal columns and have been examined in the longitudinal section of the kidney. Each renal artery gives off a branch, the *inferior suprarenal artery*, to the suprarenal gland and some twigs to the ureter and to the surrounding cellular tissue. The *renal veins* open into the inferior vena cava. The left vein is the longer and receives

in addition the left testicular or ovarian vein and sometimes the left suprarenal vein.

The **Testicular Arteries** (Internal spermatic arteries) are two long slender branches of the abdominal aorta which issue below the origin of the renal arteries. Each vessel passes downwards and lateralwards to the abdominal inguinal ring crossing the psoas major, the ureter and the external iliac artery. The right artery passes in front of the inferior vena cava and behind the terminal part of the ileum. The left artery passes behind the iliac part of the descending colon. Its course through the inguinal canal with the other constituents of the spermatic cord to the testis has been examined. The right *testicular vein* opens into the inferior vena cava while the left one opens into the left renal vein.

The **Ovarian Arteries** in the female correspond to the testicular arteries in the male. In the abdomen proper they have the same course as the testicular arteries and enter the pelvis by crossing the commencement of the external iliac artery. Their distribution to the ovaries will be examined during the dissection of the female pelvis. The *ovarian veins* end in the same way as the testicular veins.

The **Lumbar Arteries**, usually four in number on each side, arise from the back part of the aorta. They resemble and are in series with the intercostal arteries. They run lateralwards upon the bodies of the lumbar vertebræ, beneath the sympathetic trunk and disappear behind the psoas major by passing beneath the fibrous arches which give origin to this muscle. Their further course behind the muscle will be noticed later on. The *lumbar veins* open into the inferior vena cava.

The **Middle Sacral Artery** arises from the back of the aorta a little above its bifurcation. It descends in the middle line into the pelvis minor along the bodies of the fourth and fifth lumbar vertebræ. Its further course in the pelvis will be studied later on. The *middle sacral vein* opens into the left common iliac vein.

The **Common Iliac Arteries** (Fig. 35) are the terminal branches of the abdominal aorta. They commence a little to the left side of the fourth lumbar vertebra and pass downwards and lateralwards and divide opposite the lumbo-sacral articulation into the external iliac and hypogastric arteries. The right common iliac artery is longer than the left. Each artery lies upon the fourth and fifth lumbar vertebræ, is covered by peritoneum and the small intestine and is crossed by the ureter. The inferior vena cava,

the right common iliac vein and the psoas major muscle lie on the lateral side of the right artery. The left common iliac vein lies medial and the psoas major muscle lateral to the left artery.

Four to six lymph glands called *common iliac glands* lie on the sides of and behind the common iliac artery. Their efferents pass to the lateral aortic lymph glands.

The **Common Iliac Veins** (Fig. 35) are formed by the union of the external iliac and hypogastric veins. The right common iliac vein is placed at first behind and then lateral to the companion artery. The left common iliac vein is longer than the right, lies to the medial side of its companion artery and then passes behind the right common iliac artery to unite with the vein of the opposite side forming the inferior vena cava. *Tributaries.*—Each common iliac vein receives the ilio-lumbar vein and the left common iliac vein receives in addition the middle sacral vein.

The **External Iliac Artery** (Fig. 35) begins opposite the lumbosacral articulation at the bifurcation of the common iliac artery. It extends to a point behind the inguinal ligament midway between the symphysis pubis and the anterior superior iliac spine, where it becomes the femoral artery. Its direction is indicated on the surface of the abdomen by the lower two thirds of a line drawn from a point to the left side and a little below the umbilicus to a point midway between the symphysis pubis and the anterior superior iliac spine. It lies under cover of the ileum on the right side and the sigmoid colon on the left side. The external spermatic branch of the genito-femoral nerve and the testicular vessels cross the artery near its termination. The psoas major muscle lies at first laterally and then behind the artery. Its companion vein lies medially. The external iliac lymph glands, eight to ten in number lie on the sides of the artery. The branches of the external iliac artery are (1) the *inferior epigastric* and (2) the *deep circumflex iliac*. Both have their origin just above the inguinal ligament. Their course and distribution have been examined during the dissection of the anterior abdominal wall.

The **External Iliac Vein** is the continuation of the femoral vein and has an extent like the companion artery. It lies at first medial to and then behind its companion artery on the right side while on the left side it lies on the medial side of the artery throughout its course. The inferior epigastric and deep circumflex iliac veins open into it.

The **Cisterna Chyli** (Receptaculum chyli) is the expanded commencement of the thoracic duct. It is situated in front of

the first and second lumbar vertebræ between the aorta and the right crus of the diaphragm and is about two inches (5 cm.) in length. It contracts above and becomes the thoracic duct, which enters the thorax through the aortic opening in the diaphragm. The azygos vein lies on its right side. It receives the following efferent lymph vessels: (1) the *right* and *left common lumbar lymph trunks* which are formed by the efferent lymph vessels from the lateral aortic lymph glands lying at the sides of the inferior vena cava and aorta and join the lower end of the cisterna; (2) the *intestinal lymph trunk* from the preaortic lymph glands, which joins the cisterna at its middle; (3) the two *lower thoracic lymph trunks* from the lower intercostal lymph glands which join the cisterna at its upper end.

The **Azygos Vein** (Vena azygos major) is the continuation upwards of the right ascending lumbar vein. It lies between the cisterna chyli and the right crus of the diaphragm and enters the thorax through the aortic opening with the thoracic duct.

The **Hemiazygos Vein** (Vena azygos minor) is the continuation upwards of the left ascending lumbar vein. It pierces the left crus of the diaphragm and enters the thorax.

The **Inferior Vena Cava** (Fig. 35) is the large venous channel which returns the blood from the lower extremities and the abdomen to the heart. It is formed by the union of the two common iliac veins on the body of the fifth lumbar vertebra. It ascends on the bodies of the vertebræ along the right side of the abdominal aorta to the under surface of the liver. It is then lodged in a deep groove, fossa for the inferior vena cava, on the posterior surface of that organ. As it leaves the liver it pierces the central tendon of the diaphragm and opens into the right atrium. In front of it are the mesentery, the right testicular artery, the duodenum, the pancreas, the portal vein, and the posterior surface of the liver. Its tributaries are: the two common iliac, lumbar, right testicular or ovarian, renal, right suprarenal, inferior phrenic, and hepatic veins.

Lymph Glands.—During the dissection of the abdomen the student has noticed clusters of lymph glands associated with large blood vessels. These may be grouped in the following manner:—(1) The *external iliac lymph glands*, about ten in number, arranged on the medial and lateral sides of the external iliac vessels. Their afferents are derived from the inguinal and subinguinal lymph glands, the deep lymphatic vessels of the abdominal wall below the umbilicus, corresponding to the area of dis-

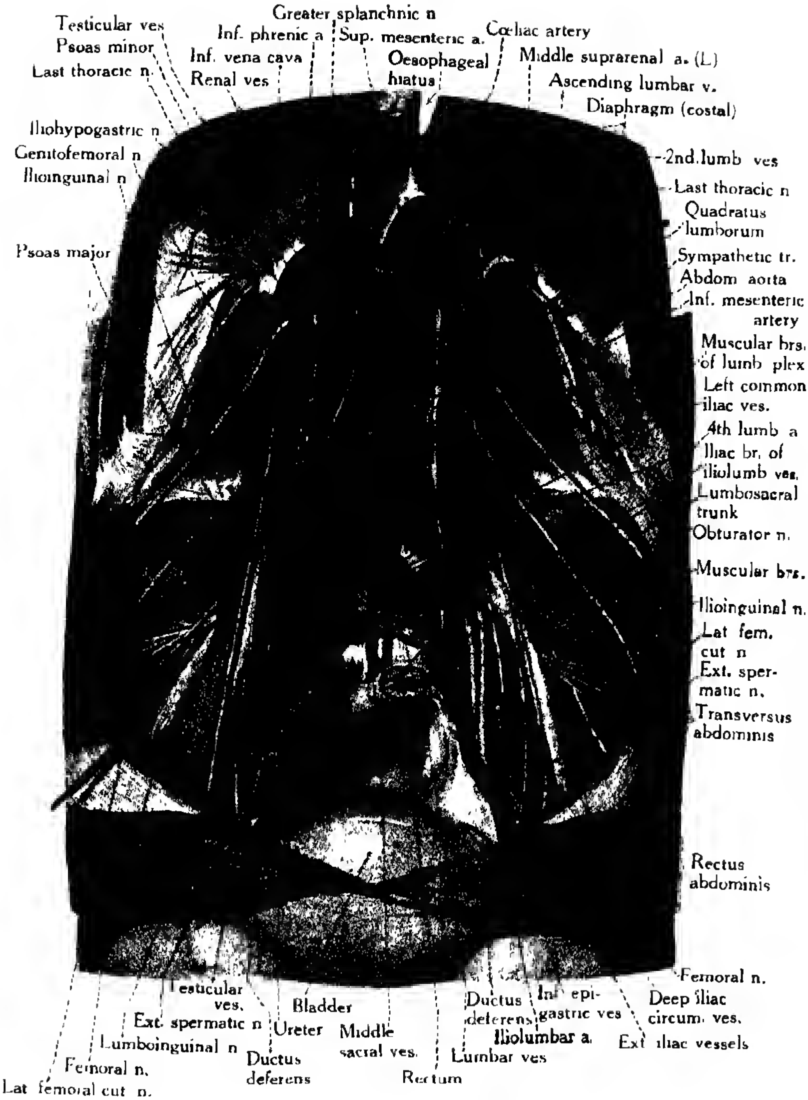

Fig. 35.—Dissection of the muscles, vessels, and nerves on the posterior wall of the abdomen (Sobotta).

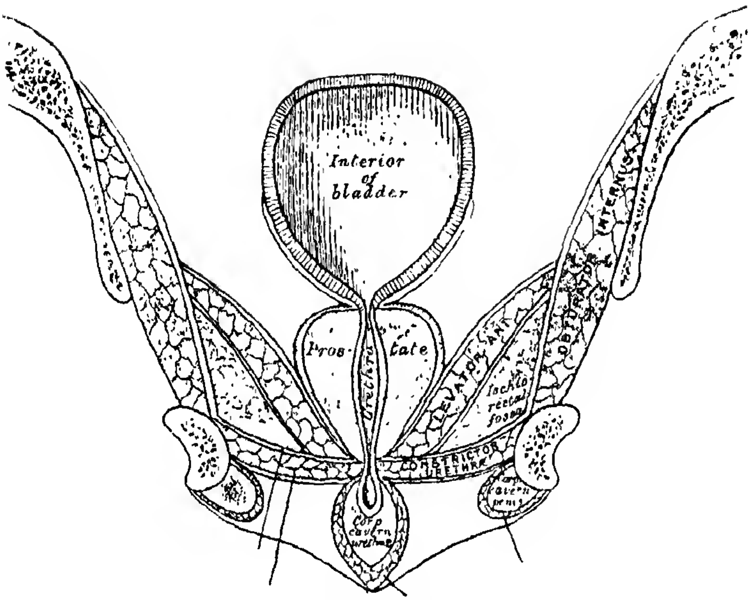

Fig 37.—Diagram showing the arrangement of the pelvic fascia. The pelvic fascia is represented in red. (After Gray).

(Coronal Section)

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tribution of the inferior epigastric and deep circumflex iliac arteries. Their efferents pass to the common iliac lymph glands. (2) The *common iliac lymph glands,* about six in number, lie behind and on the sides of the common iliac artery ; their afferent vessels are derived from the external iliac and hypogastric lymph glands. Their efferents pass into the lumbar lymph glands. (3) The *lumbar lymph glands* consist of three groups. (*a*) Those situated in front of and behind the inferior vena cava are called the *right lateral aortic lymph glands*. (*b*) Those on the left side of the abdominal aorta are called the *left lateral aortic lymph glands*. Both right and left groups receive the efferents of the common iliac lymph glands, the lymph-vessels from the kidneys and suprarenal glands and the lateral abdominal muscles. Their efferents form the *right* and *left lumbar lymph trunks* which open into the cisterna chyli. (*c*) The *preaortic lymph glands* are situated in front of the abdominal aorta and chiefly surround the origins of the cœliac, superior mesenteric and inferior mesenteric arteries. Their afferents are derived from the viscera supplied by these arteries and their efferents unite to form the *intestinal lymph trunk* which opens into the cisterna chyli.

FASCIÆ AND MUSCLES ON THE POSTERIOR ABDOMINAL WALL

Dissection. The muscles and fasciæ of the posterior abdominal wall should now engage the attention of the dissector. These are the psoas major, iliacus and quadratus lumborum and the fasciæ which cover these muscles. Keep intact the medial portion of the fascia iliaca so that its connection with the pelvic fascia may be demonstrated. When cleaning the psoas major muscle take care of (1) the femoral nerve which will be seen between the psoas and iliacus ; (2) the lateral femoral cutaneous nerve and ilio-inguinal nerve which will be noticed at the lateral border of the psoas ; (3) the genito-femoral nerve which will be seen on its anterior surface ; (4) the sympathetic trunk which will be found on its anterior border. When cleaning the quadratus lumborum, take care of (1) the ilio-hypogastric and ilio-inguinal nerves which run over it obliquely ; and (2) the last thoracic nerve which passes laterally in front of it.

The **Fascia Iliaca** covers the anterior surfaces of the iliacus and psoas muscles as one continuous membrane. Above the level of the iliac crest it is thin but becomes thick near the

inguinal ligament. It is attached laterally to the inner lip of the crest of the ilium; medially to the brim of the lesser pelvis; inferiorly it is attached to the inguinal ligament lateral to the external iliac vessels where it is continuous with the fascia transversalis; behind the external iliac vessels and beyond the inguinal ligament it is prolonged into the thigh as the *ilio-pectineal fascia* which covers the iliacus and psoas muscles on the thigh, forms the posterior wall of the femoral sheath and becomes continuous medially with the pectineal fascia. Superiorly above the level of the iliac crest the fascia iliaca is prolonged over and covers the psoas major muscle only. Here it is attached medially to the intervertebral fibro-cartilages and the contiguous prominent margins of the bodies of the lumbar vertebræ by a series of fibrous arches; laterally it is continuous with the fascia covering the quadratus lumborum; superiorly it forms the thickened arched band called the *medial lumbo-costal arch.*

The **Fascia covering the Quadratus Lumborum** covers the muscle anteriorly. It is attached medially to the front of the transverse processes of the lumbar vertebræ where it is continuous with the fascia iliaca covering the psoas major; laterally it is continuous with the anterior layer of the lumbo-dorsal fascia; below it is attached to the ilio-lumbar ligament and the contiguous part of the iliac crest; and above to the tip and the lower border of the twelfth rib forming the thickened arched band called the *lateral lumbo-costal arch.*

The **Psoas Major** (Psoas magnus) (Fig. 35) arises (1) from the anterior surfaces and lower borders of the transverse processes of all the lumbar vertebræ, (2) from the intervertebral fibrocartilages and the adjacent prominent margins of the bodies of the twelfth thoracic and all the lumbar vertebræ, by five slips—the first slip arises by the adjacent margins of the bodies of the twelfth thoracic and first lumbar vertebræ and the intervertebral fibrocartilage between them. and the fifth slip from the adjacent margins of the lower two lumbar vertebræ and the interposed fibrocartilage, and (3) from the tendinous arches which bridge over the lumbar vessels along the sides of the bodies of the lumbar vertebræ. The muscle passes downwards along the brim of the lesser pelvis. Proceeding behind the inguinal ligament it ends in a tendon which receives the insertion of the iliacus on its lateral side and is inserted into the lesser trochanter of the femur. *Nerve-supply.*—It is supplied by branches from the second and third lumbar nerves. *Action.*—Acting from above it flexes the thigh

on the pelvis in conjunction with the iliacus. When it acts from below it bends the lumbar portion of the vetebral column forwards.

The **Psoas Minor** (Psoas parvus) is sometimes present. It arises from the bodies of the twelfth thoracic and first lumbar vertebræ and from the fibrocartilage between them. The muscle fibres soon end in a long tendon which passes along the front and medial aspect of the psoas major to be inserted into the iliopectineal eminence, pecten pubis and iliac fascia. It is supplied by a branch from first lumbar nerve. *Action.*—It is a tensor of the iliac fascia.

The **Iliacus** is triangular in form and arises (1) from the base of the sacrum; (2) from the anterior sacro-iliac and ilio-lumbar ligaments, and (3) from the upper part of the iliac fossa and the inner lip of the iliac crest. It is inserted (1) into the lateral side of the tendon of the psoas major, (2) into the lesser trochanter of the femur in common with the tendon of the psoas major, and (3) into the surface of bone below the lesser trochanter. It is supplied by a branch from the femoral nerve. *Action.*—Acting from above it flexes the thigh on the pelvis in conjunction with the psoas major. Acting from below it bends forwards the pelvis.

The **Quadratus Lumborum** arises (1) from the ilio-lumbar ligament, (2) from the adjacent part of the iliac crest, and (3) from the tips of the transverse processes of the lower two or three lumbar vertebræ. It is inserted (1) into the medial half of the lower border of the last rib and (2) into the tips of the transverse processes of the upper three or four lumbar vertebræ. It is supplied from the twelfth thoracic and first and second lumbar nerves. *Action.*—It draws down the last rib and hence helps inspiration. It also flexes the vertebral column laterally.

NERVES ON THE POSTERIOR ABDOMINAL WALL

Dissection.—The dissection of the nerves on the posterior wall of the abdomen should now engage the attention of the student. These are the sympathetic trunk and the anterior divisions of the lumbar nerves which form the lumbar plexus. The sympathetic trunk lies along the anterior margin of the psoas major. It is to be cleaned and the branches which proceed from its ganglia to the lumbar nerves as also its branches to the aortic and hypogastric plexuses are to be followed.

Sympathetic System.—The general plan of arrangement of the sympathetic system of nerves should be understood by the student. In the first place he should know that there is the **autonomic nervous system** in the human body, the action of which is independent of the control of the will. It innervates the unstriped muscles, viscera, glands and blood vessels. This system is subdivided into two secondary systems: the parasympathetic and the sympathetic. The **parasympathetic system** consists of a cranial and a sacral portion. The *cranial parasympathetic system* consists of groups of nerve cells situated in the midbrain and hindbrain from which autonomic nerve fibres issue inseparably with certain cerebral nerves, viz., the oculomotor, the facial, the glossopharyngeal, the vagus and the accessory nerves. These will be considered in detail in connection with cerebral nerves. The *sacral parasympathetic system* consists of groups of nerve cells situated in the sacral segment of the medulla spinalis from which parasympathetic fibres issue inseparably with the second, third and fourth sacral nerves. These will be considered in detail in connection with the sacral nerves and the pelvic plexuses. The *sympathetic system* on the other hand consists of a separate series of ganglia which are connected by intervening cords all visible to the naked eye and extending from the first cervical vertebra to the coccyx. From this gangliated cord communicating branches are given off to the cerebral and spinal nerves as also branches to the viscera along blood-vessels forming plexuses upon them. Functionally the parasympathetic system is antagonistic to the sympathetic system, *e.g.*, the parasympathetic fibres passing with the oculomotor nerve innervate the sphincter of the pupil and thus cause its contraction whereas the sympathetic fibres innervate the dilator of the pupil and thus cause its dilatation.

Sympathetic Trunk (Fig. 35).—The *abdominal portion of the sympathetic trunk* is continuous above with the thoracic portion behind the medial lumbo-costal arch. It is placed on the bodies of the lumbar vertebræ along the medial border of the psoas major muscle. On the right side it lies behind the inferior vena cava and on the left side it lies to the left of the aorta. Below it becomes continuous with the pelvic portion of the sympathetic trunk by passing behind the common iliac artery. In the lumbar portion usually four ganglia will be noticed, from which *grey rami communicantes* pass laterally and branches of distribution pass medially. The grey rami communicantes, one from each

ganglion, pass from all the four ganglia to the corresponding lumbar spinal nerves. The first and second and sometimes the third lumbar spinal nerves send *white rami communicantes* to the corresponding ganglia. The rami accompany the lumbar arteries. The *branches of distribution* are many filaments which pass medially to form chiefly the aortic plexus, but some pass downwards to join the hypogastric plexus.

Dissection. Remove the psoas major muscle piecemeal on one side to expose the anterior primary divisions of the lumbar nerves which pass through it. Trace these nerves to the formation of the lumbar plexus. Trace the lumbar vessels further lateralwards. Look for the branches of the lumbar plexus. The iliohypogastric and ilioinguinal nerves will be seen crossing the quadratus lumborum obliquely from the upper part of the lateral border of the psoas major. The genitofemoral nerve will be seen to emerge from the medial border of the psoas major and lie along the anterior surface of the muscle. The lateral femoral cutaneous nerve emerges from the lateral border of the psoas major at about its middle. The thick femoral nerve will be seen to lie between the iliacus and the lateral border of the psoas major. The obturator nerve emerges from the medial border of the psoas major at the back part of the brim of the lesser pelvis. The accessory obturator nerve, if present, will be seen to descend along the medial margin of the psoas major.

Lumbar Plexus (Fig. 36).—The anterior divisions of lumbar nerves are five in number. A branch from the twelfth thoracic nerve joins the first lumbar. This communicating branch together with the anterior divisions of the upper three lumbar nerves and a part of the anterior division of the fourth unite to form a series of loops called the lumbar plexus. The plexus is contained in the substance of the psoas major near the posterior surface of the muscle and is placed in front of the transverse processes of the lumbar vertebræ. The remaining part of the anterior division of the fourth lumbar nerve unites with the anterior division of the fifth lumbar to form the *lumbo-sacral trunk* which passes downwards behind the common iliac artery to join the sacral plexus. The fourth lumbar nerve is called the *nervus furcalis* on account of the fact that it divides to join both the lumbar and sacral plexuses. The usual arrangement of the plexus is as follows: the first lumbar nerve is joined by a branch from the last thoracic; it divides into three branches—the ilio-hypogastric, the ilio-inguinal, and the upper root of the genito-femoral,

Each of the second, third and fourth lumbar nerves divides into a ventral and a dorsal division and gives off other branches. The

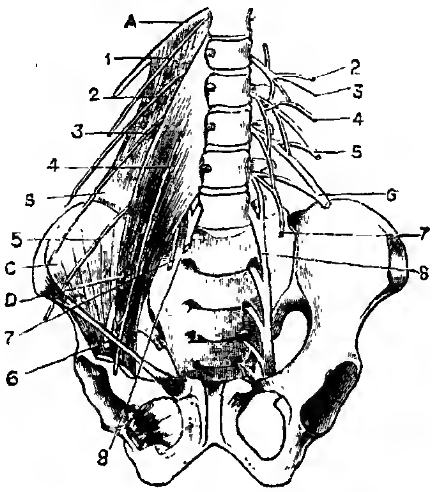


Fig. 36.—The lumbar plexus (after Cunningham).

A. Twelfth rib.
B. Quadratus lumborum.
C. Iliacus.
D. Psoas major.
1. Last thoracic nerve.
2. Ilio-hypogastric nerve.
3. Ilio-inguinal nerve.
4. Genito-femoral nerve.
5. Lateral femoral cutaneous nerve.
6. Femoral nerve.
7. Obturator.
8. Lumbo-sacral trunk.

obturator nerve is formed by the union of the three ventral divisions. The femoral nerve is formed by the union of the three dorsal divisions. The genitofemoral is formed by the union of its upper and lower root, the former being contributed by the first lumbar nerve and the latter by the ventral division of the second lumbar nerve. The lateral femoral cutaneous nerve is formed by the union of its two roots derived from the dorsal divisions of the second and third lumbar nerves. The accessory obturator nerve when present is formed by two roots derived from the ventral divisions of the third and fourth lumbar nerves. The *branches* given off from the lumbar plexus are :—

(1) *Muscular branches.*—The psoas minor is supplied from the first lumbar, the psoas major from the second and third lumbar, the quadratus lumborum from the first and second lumbar nerves.

(2) The *ilio-hypogastric nerve* arises from the first lumbar nerve and appears at the lateral border of the psoas major at its

upper part. It then passes obliquely downwards and lateralwards across the quadratus lumborum towards the iliac crest. Here it pierces the posterior part of the transversus abdominis and divides into a *lateral* and an *anterior cutaneous branch*. The former crosses the iliac crest to supply the gluteal region, while the latter has been traced to its destination (p. 25).

(3) The *ilio-inguinal nerve* arises from the first lumbar nerve. It appears at the lateral border of the psoas major just below the ilio-hypogastric nerve. It then crosses the quadratus lumborum obliquely and near the front part of the iliac crest it perforates the transversus abdominis. Its subsequent course and distribution to the skin of the scrotum or labium majus have been already examined (p. 25); its distribution to the skin of the upper and medial part of the thigh will be noticed during the dissection of that part.

(4) The *genito-femoral nerve* (genito-crural nerve) arises by two roots, one from the first lumbar and the other from the ventral division of the second lumbar. It passes through the psoas major and appears at its medial border. It then descends on the surface of the muscle and divides into two branches, the external spermatic and lumbo-inguinal nerves. The *external spermatic nerve* (genital branch) crosses the external iliac artery to gain the abdominal inguinal ring, through which it passes to supply the cremaster muscle. In the female it passes with the round ligament of the uterus and ends in the labium majus. The *lumbo-inguinal nerve* (crural branch) descends lateral to the external iliac artery and passes behind the inguinal ligament to the thigh on the lateral side of the femoral artery. Its distribution to the skin of the upper and front part of the thigh will be examined during the dissection of the inferior extremity.

(5) The *lateral femoral cutaneous nerve* (external cutaneous nerve) arises by two roots derived from the dorsal divisions of the second and third lumbar nerves. It passes through the psoas major and emerges near the middle of its lateral border. It crosses the iliacus muscle obliquely and then passes through the notch below the anterior superior iliac spine and behind the inguinal ligament to the thigh.

(6) The *femoral nerve* (anterior crural nerve) is the largest branch of the lumbar plexus and arises by three roots derived from the dorsal divisions of the second, third and fouth lumbar nerves. It runs downwards through the psoas major and appears at the lateral border of the muscle. Next it descends between

the psoas major and the iliacus and gives branches to the latter muscle. It then passes behind the inguinal ligament to the thigh.

(7) The *obturator nerve* arises by three roots from the ventral divisions of the second, third and fourth lumbar nerves. It descends through the psoas major and appears at the medial border of the muscle near the back part of the brim of the lesser pelvis. It then passes towards the upper part of the obturator foramen along the inner surface of the wall of the lesser pelvis. Accompanied by the obturator artery it passes out of the pelvis through the obturator foramen.

(8) The *accesory obturator nerve* is occasionally found. It arises either from the obturator nerve or from the ventral divisions of the third and fourth lumbar nerves. It passes downwards along the medial border of the psoas major and reaches the thigh by crossing the superior ramus of the os pubis behind the pectineus.

The *anterior division of the last thoracic nerve* gives a communicating twig to the first lumbar nerve and then passes along the lower border of the twelfth rib across the quadratus lumborum accompanied by the subcostal artery. Near the lateral border of that muscle it pierces the transversus abdominis and then runs forwards between the transversus and internal oblique muscles in the anterior abdominal wall where its distribution has already been seen (p. 25).

The portions of the *lumbar arteries* which were covered by the psoas major are now exposed. They are four in number on either side. Traced backwards at the intervals between the transverse processes each artery is found to give off a dorsal branch. The *dorsal branch* passes backwards and opposite the intervertebral foramen gives off a *spinal branch* which enters the vertebral canal. The termination of the dorsal branch in the muscles and skin of the back will be seen during the dissection of the back. The upper three lumbar arteries after giving off their dorsal branches pass behind the quadratus lumborum while the lower one passes in front of it. Their subsequent course between the transversus and the internal oblique has been noted. The *subcostal arteries* are the last parietal branches of the thoracic aorta and are in series with the intercostal arteries. Each passes over the quadratus lumborum along the lower border of the twelfth rib in company with the twelfth thoracic nerve.

The *lumbar veins* have the same course as the arteries; the

left veins are longer than the right, and open into the inferior vena cava. In front of the transverse processes of the lumbar vertebræ a longitudinal vein is seen to connect together the lumbar veins. This is called the ***ascending lumbar vein*** and is continued on the right side as the azygos vein and on the left side as the hemiazygos vein.

THE PELVIS

Dissection. The lower limbs have already been removed. The pelvis should now be detached from the trunk by cutting through the intervertebral fibrocartilage between the third and fourth lumbar vertebræ and by severing other soft structures as may be necessary.

Boundaries and Subdivisions.—The pelvis is bounded behind by the sacrum and coccyx, in front and laterally by the two hip bones. Certain ligaments, fasciæ and muscles contribute to the formation of the pelvic wall, viz., posteriorly the sacrotuberous and sacrospinous ligaments and the two piriformes muscles, anteriorly the urogenital diaphragm, and laterally the obturator membrane and obturator internus muscle. The portion of the pelvic cavity above the level of the pelvic brim is called the greater pelvis (false pelvis) This part has been studied during the dissection of the abdominal cavity. The portion of the pelvis which is situated below the brim is called the lesser pelvis (true pelvis) ; the student should now engage himself with the dissection of the lesser pelvis.

LESSER PELVIS IN THE MALE

The relative positions of the chief viscera are as follows :—
In front is the bladder with the prostate gland lying below it. Behind are the sigmoid colon and rectum. Between the bladder and the rectum are the vesiculæ seminales and the ductus deferentes. The ureters descend by the sides of the rectum and proceed below the ductus deferentes to the base of the bladder.

The **Peritoneum** as it lines the lesser pelvis has been traced in a general way with the vertical tracing of the membrane in the abdominal cavity. The disposition of the peritoneum and its fossæ in the pelvis are now to be examined in detail. Traced along the posterior wall it encircles the sigmoid colon and fixes it to the posterior wall by a loose fold called the ***sigmoid mesocolon.***

Lower down it covers the upper third of the rectum in front and at the sides but not posteriorly. Further down it covers the middle third of the rectum only on its anterior aspect and thence is prolonged on to the superior surface of the bladder covering the upper ends of the seminal vesicles. A depression is seen on either side of the rectum called the *pararectal fossa.* From the back part of the superior surface of the bladder at their end is a fold of peritoneum which extends backwards and lateralwards towards the sacrum. These folds are called the *sacro-genital* or *recto-vesical folds* (posterior false ligaments of the bladder). From the superior surface of the bladder the peritoneum is reflected laterally on to the lateral wall of the pelvis forming the *false lateral ligaments* of the bladder. On either side of the bladder a shallow peritoneal fossa is seen called the *paravesical fossa.* From the vertex of the bladder the peritoneum is reflected on to the anterior abdominal wall covering the middle of umbilical ligament. This is called the *middle umbilical fold* (superior false ligament of the bladder). The fossa lying between the rectum behind and the bladder in front is called the *recto-vesical excavation.*

It will be noticed from the description given above that the **peritoneal fossæ** seen in the lesser pelvis, in the male, are : (1) the pararectal fossa, situated on either side of the rectum ; (2) the paravesical fossa, placed on either side of the bladder ; (3) the rectovesical excavation lying between the rectum and bladder.

Dissection. The pelvic fascia should now be displayed and studied. Detach the peritoneum from the right side of the pelvic wall towards the bladder and rectum. Next scrape away the extraperitoneal fatty tissue with the handle of the knife. The fascia lining the wall of the lesser pelvis is now seen. As the inferior extremity has been removed the obturator externus muscle and the remains of the muscles attached to the ischium and the pubis should be cleared away. Then snip through the spine of the ischium near the base with bone pliers and saw through the ischium along a line extending from the lower part of the small sciatic notch to the lower part of the obturator foramen. Next saw through the ischium along a line extending from the upper part of the great sciatic notch to the upper part of the obturator foramen. The detached portion of bone should now be separated from the obturator internus muscle which arises from its inner aspect. The muscle itself should be cleaned and its tendon is to be tied with a piece of string and drawn forwards.

A good view of the outer surface of the greater portion of the parietal pelvic fascia is thus obtained.

The **Pelvic Fascia** (Fig. 37) is divisible into two portions, a parietal portion which lines the wall of the lesser pelvis and a visceral portion which is prolonged on the viscera to support them. The *parietal portion* is subdivided into three parts according to its situation. These are (1) the fascia of the piriformis, (2) the fascia of the obturator internus and (3) the diaphragmatic part of the pelvic fascia.

(1) The *fascia of the piriformis* is the back part of the parietal layer covering the piriformis muscle. It is attached to the front of the sacrum medial to the anterior sacral foramina. It is pierced by vessels and nerves which pass to the gluteal region through the great sciatic notch.

(2) The *fascia of the obturator internus* is the front part of the parietal layer covering the pelvic surface of the obturator internus muscle. Above it is attached to the back part of the iliopectineal line where it is continuous with the iliac fascia. Further in front it recedes from the iliopectineal line following the origin of the obturator internus and arches beneath the obturator vessels and nerve at the upper end of the obturator foramen forming the obturator canal. Traced further in front it is attached to the back part of the superior ramus of the pubis. Below it is attached to the falciform process of the sacrotuberous ligament and to the inferior rami of the ischium and pubis. Then it bridges over the triangular gap between the inferior rami of the ischium and os pubis of the two sides forming the superior layer of the urogenital diaphragm. Behind it is attached to the anterior margin of the greater sciatic foramen and is continuous with the fascia of the piriformis. As the obturator fascia descends towards the ischial tuberosity and before it becomes attached to the sacrotuberous ligament it splits to enclose an anteroposterior canal, called *Alcock's canal*, through which the internal pudendal vessels and the pudendal nerve proceed to the perineum.

(3) The *diaphragmatic part of the pelvic fascia* covers both surfaces of the pelvic diaphragm, *i.e*, the levatores ani and coccygei muscles. The layer that lines the inferior surfaces of the levator ani and coccygeus is called the *anal fascia*. The student can examine it by looking into the ischiorectal fossa of which it forms the medial boundary. It is attached above to the obturator fascia along the line of origin of the levator ani muscle from it,

Below it passes to the margin of the anus following the insertion of the levator ani. The *superior layer of the diaphragmatic fascia* lines the upper surface of the levator ani and coccygeus muscles. It is attached above to the obturator fascia along a whitish line called the *white line.* This white line may be examined from its inner and outer aspects. By pulling the detached ischial spine backwards it will be put on the stretch and will be seen to extend from the spine of the ischium to the back part of the symphysis pubis a little above its lower end. Below the superior layer is attached along the line of insertion of the levator ani muscle.

The *visceral layer* of the pelvic fascia or *fascia endopelvina* is the layer which passes medialwards from the white line towards the pelvic viscera. It blends inferiorly near the white line with the superior layer of the diaphragmatic fascia. Traced towards the median line it meets with the bladder in front, the rectum behind and the ductus deferentes and vesiculæ seminales in the intermediate space. Thus it is divisible into three portions; viz., (*a*) a vesical layer, (*b*) a rectal layer, and (*c*) a rectovesical layer.

The *vesical layer* passes medialwards to the front and lateral aspects of the bladder. If the bladder is pulled backwards it will be found to extend from the back part of the quadrilateral portion of the pubis to the bladder as a thickened band called the *true anterior ligament of the bladder.* If the bladder is pulled to the left the vesical layer will be seen to be attached to the right lateral surface of the bladder as a thickened band called the *true lateral ligament of the bladder.* In males the vesical layer is prolonged on the prostate gland covering it in front and at the sides as a sheath.

The *rectal layer* is the posterior portion of the visceral layer. It passes to the side of the rectum and is prolonged on it as a tubular sheath to the anal canal to be continuous with the anal fascia below.

The *recto-vesical layer* is the intermediate portion of the visceral layer which passes medialwards between the bladder in front and the rectum behind. At the lateral border of the vesiculæ seminales and the ductus deferentes it splits into two laminæ, an upper and a lower which enclose those structures. At their medial border the two laminæ reunite to be continuous with the similar reunited layer of the opposite side. The splitting at the lateral border of the vesiculæ seminales can be demons-

trated by cutting the rectovesical layer at that line. It also covers the posterior surface of the prostate gland.

Dissection. The viscera of the pelvis are now to be cleaned. The fat around the rectum is to be cleared without injuring its arteries ; the ureters which descend by its sides are to be defined. The bladder is to be cleaned without injuring its ligaments and arteries. The ductus deferens is to be defined and traced to the seminal vesicle.

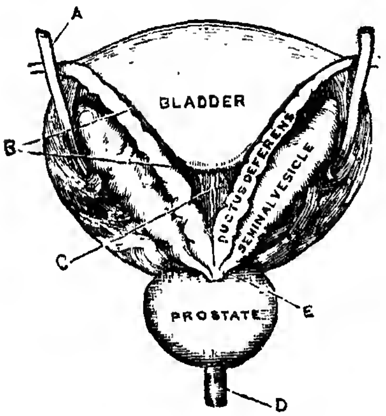
Sigmoid Colon (Pelvic colon).—Its position and attachment to the pelvic wall by sigmoid mesocolon have been examined.

The **Rectum** begins opposite the third sacral vertebra and descends along the front of the sacrum and coccyx with its concavity forwards (*sacral flexure*). Below the tip of the coccyx on a level with the apex of the prostate gland it curves backwards with its convexity to the front (*perineal flexure*) to end in the anal canal. Near its termination it presents a dilatation called the *rectal ampulla*. When viewed from the front the rectum presents three lateral bends or flexures of which two have their concavities turned to the left and the third to the right. Opposite these flexures are seen the conspicuous permanent transverse folds in the interior of the gut. At its upper third it is covered in front and at the sides by peritoneum ; its middle third is covered in front only. Its lower third is uncovered by peritoneum as the membrane is reflected on to the vesiculæ seminales and bladder in the male and to the posterior vaginal wall and uterus in the female. Posteriorly the rectum is in relation with the sacrum and coccyx to which it is connected by loose areolar tissue ; anteriorly it has in the male the base of the bladder, the ductus deferentes, the vesiculæ seminales and the prostate gland ; while in the female it is in relation with the posterior wall of the vagina.

The **Anal Canal** is about an inch (2.5 cm.) in length. It begins opposite the apex of the prostate and ends at the anus. It is devoid of peritoneum and is covered by a portion of the rectal layer of the pelvic fascia. The canal is encircled by the sphincter ani internus and supported by the levatores ani while the sphincter ani externus surrounds it at its termination.

The **Urinary Bladder** (Fig. 38) is the receptacle for the urine. Its shape and position vary with the amount of fluid contained in it. When empty it is placed entirely within the pelvic cavity reaching as far as the upper border of the symphysis pubis ; when distended it protrudes into the abdominal cavity. The *empty bladder* presents for examination (1) a fundus or base, (2)

a vertex or apex, (3) a superior surface, (4) an inferior surface, (5) two lateral borders and (6) a posterior border. The *fundus* or *base* is triangular, and directed towards the rectum. It is not covered by peritoneum; it is separated from the rectum by the rectovesical fascia, the ductus deferentes and the vesiculæ seminales. The *vertex* or *apex* is directed forwards towards the upper border of the symphysis pubis and from it the middle umbilical ligament (urachus) extends along the anterior abdominal wall to the umbilicus. The *superior surface* is covered by peritoneum and is in relation with the sigmoid colon and some coils of the small intestine. The *inferior surface* is directed downwards and is not covered by peritoneum. It is divisible



A Left ureter.

B. Line of reflection of peritoneum.

C. External trigone.

D. Urethra.

E. Ejaculatory duct of right side.

Fig. 38.—Dissection of the base of the bladder, showing the vesiculæ seminales and ductus deferentes (after Buchanan).

into a posterior or prostatic area which lies against the base of the prostate gland and from which the urethra issues; and two infero-lateral surfaces which are separated from the symphysis pubis by a mass of fatty tissue called the *retropubic pad.* The *lateral borders* form the lateral boundaries of the superior surface and the *posterior border* forms its posterior boundary. At the junction of the posterior and lateral borders are the openings of the ureters.

Distend the bladder through one of the ureters by a blow pipe.

The *distended bladder* presents a fundus, a vertex, a postero-superior surface, an antero-inferior surface and two lateral surfaces. The *fundus* is slightly lowered and the *vertex* is directed

upwards and forwards. The *postero-superior surface* is directed upwards and backwards. The *antero-inferior surface* is directed downwards and forwards, is devoid of peritoneum, and rests against the pubic bones and anterior abdominal wall. The *lateral surfaces* are uncovered by peritoneum at their lower parts.

In the newborn child the form and position of the bladder differ from the adult. It is piriform in shape, has no basal portion and rises much above the pelvic brim into the hypogastric region. It quickly tapers down to the urethra ; the internal urethral orifice is at the level of the upper border of the symphysis pubis. During the early years of life the urethral orifice rapidly sinks and after puberty the bladder attains its final position.

The *false ligaments of the bladder* formed by the folds of peritoneum viz., the two lateral, the superior, and the two sacro-genital folds have been described. Of the *true ligaments*, the two anterior and the two lateral have been studied in connection with the pelvic fascia ; while the middle umbilical ligament (urachus) has been noticed during the dissection of the anterior abdominal wall.

Ureters.—In the pelvis the ureter descends in front of the hypogastric artery to the level of the lower border of the great sciatic notch. It then turns medialwards and is crossed by the ductus deferens. Reaching the lateral angle of the bladder the ureter pierces its wall and passes obliquely through the wall for three-fourths of an inch before opening into the bladder.

Dissection. The position and relation of the prostate gland should now be studied. Clean the rectovesical fascia enclosing the ductus deferens and vesicula seminalis on the right side. Trace the ductus deferens towards the base of the prostate gland.

The **Prostate Gland** is a conical body about one and a quarter inches long from base to apex, and one and a half inches broad from side to side. Its *apex* is directed downwards resting on the superior fascia of the urogenital diaphragm. The *base* is directed upwards towards the bladder and surrounds the first part of the urethra. Its *anterior surface* lies behind the symphysis pubis to which it is attached by the pubo-prostatic ligaments or the anterior true ligaments of the bladder. Divide these ligaments and note the dorsal vein of the penis entering the pelvis below the pubic arcuate ligament to join the *pudendal plexus of veins* which lies behind that ligament and in front of the bladder and prostate gland. The *posterior surface* lies against the **rectum**

and can be felt by passing the finger through the rectum. The *lateral surfaces* are embraced by the levatores ani. The gland is invested by a prolongation of the visceral layer of the pelvic fascia which forms its *sheath*.

The **Ductus Deferens** (Vas deferens) has been traced up to the abdominal inguinal ring through which it enters the abdominal cavity lateral to the inferior epigastric artery. It now separates from the other structures of the spermatic cord, descends medial to the external iliac vessels and enters the lesser pelvis. It next runs backwards between the lateral wall of the pelvis and the peritoneum, crosses the umbilical artery, the obturator nerve and the ureter and turns medialwards to the medial side of the vesicula seminalis. It then passes downwards and medialwards in contact with the vesicula seminalis and gradually approaches its fellow of the opposite side. Here both the duct and vesicle are enclosed in the rectovesical fascia. Finally it passes to the base of the prostate and joins the duct of the seminal vesicle to form the *ejaculatory duct*. The upper part of the duct has a very small calibre ; the lower part where it lies on the medial side of the vesicula seminalis is dilated and tortuous and is called the *ampulla* ; the terminal part which joins the duct of the vesicle is very narrow.

The **Vesiculæ Seminales** are two sacculated reservoirs for the fluid secreted by the testis, viz., semen. Each vesicle is about two inches and a half (6 cm.) in length. Its *anterior surface* is in contact with the fundus of the bladder. Its *posterior surface* rests on the rectum from which it is separated by the rectovesical layer of the pelvic fascia. Its *upper end* is broad ; its *lower end* is constricted and terminates in a duct which joins the ductus deferens to form the ejaculatory duct. The vesicles diverge from each other above but at their lower ends they are separated from each other only by the ductus deferentes. Each vesicle is only a tube coiled upon itself several times and gives off several diverticula--the coils and diverticula are embedded in fibrous tissue. If uncoiled the tube is found to be about six inches (15 cm.) long.

Dissection. The dissector should now display the hypogastric artery and its branches on the left side. For this purpose the peritoneum is to be peeled off and the pelvic fascia removed. The branches of the hypogastric artery and their companion veins are to be traced, and the nerve filaments which lie connected with these branches should be preserved as far as possible. The

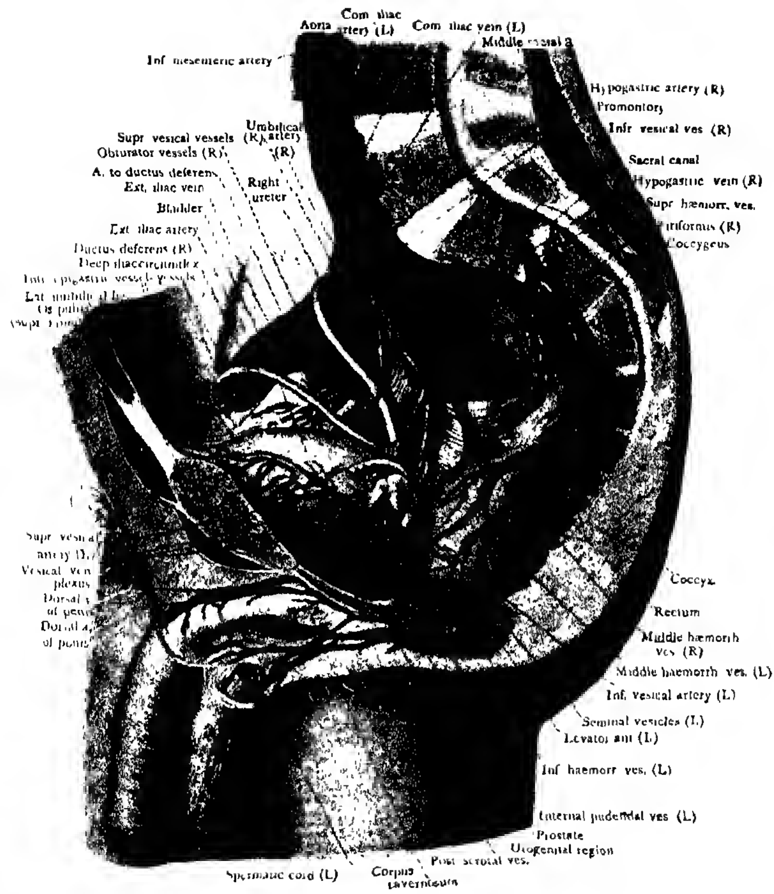


Fig. 39.—The interior of the male pelvis showing the vessels (Sobotta).

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sympathetic trunk and the pudendal and coccygeal plexuses are not to be injured when the pelvic fascia lying in front of them is removed from the sacrum. The middle sacral and superior hæmorrhoidal arteries which are seen near the median plane, and the sacral nerves are to be preserved.

The **Hypogastric Artery** (Internal iliac artery) arises opposite the lumbo-sacral articulation from the bifurcation of the common iliac artery. It passes to the upper margin of the greater sciatic foramen and then divides into an anterior and a posterior division. *Anteriorly* it is covered by peritoneum and crossed by the ureter, while *posteriorly* are the hypogastric vein and the lumbo-sacral nerve trunk. Lateral to it are the external iliac vein, the psoas major muscle and the obturator nerve. In the fœtus the hypogastric artery is twice the size of the external iliac artery and ascends on the back part of the anterior abdominal wall to the umbilicus, where it meets with its fellow of the opposite side. The two hypogastric arteries pass through the umbilicus to the placenta along the umbilical cord as the *umbilical arteries*. After birth the pelvic portion of the hypogastric artery remains patent and forms the hypogastric artery and the proximal part (one to two inches) of the superior vesical artery. The remainder of the vessel up to the umbilicus is converted into a fibrous cord, called the *lateral umbilical ligament* (obliterated hypogastric artery).

Branches of the Hypogastric Artery.—From the anterior division three visceral branches viz., the superior vesical, the inferior vesical and the middle hæmorrhoidal, and three parietal branches, viz., the obturator, the internal pudendal and the inferior gluteal are given off. From the posterior division three parietal branches viz., the ilio-lumbar, the lateral sacral and the superior gluteal are given off.

Superior Vesical Artery.—Its first portion is the proximal pervious part of the fœtal hypogastric artery. It gives off many small branches which supply the upper part of the bladder. From one of these branches a small twig, the *artery to the ductus deferens*, is given off which accompanies the duct to the testis.

The **Inferior Vesical Artery** usually arises in common with the middle hæmorrhoidal. It supplies the fundus of the bladder, the vesicula seminalis, the ductus deferens and the prostate.

The *vesical veins* commence in a venous plexus called the *vesical plexus*. This plexus is situated on the inferior surface

of the bladder surrounding the base of the prostate gland. The vesical veins terminate in the hypogastric vein.

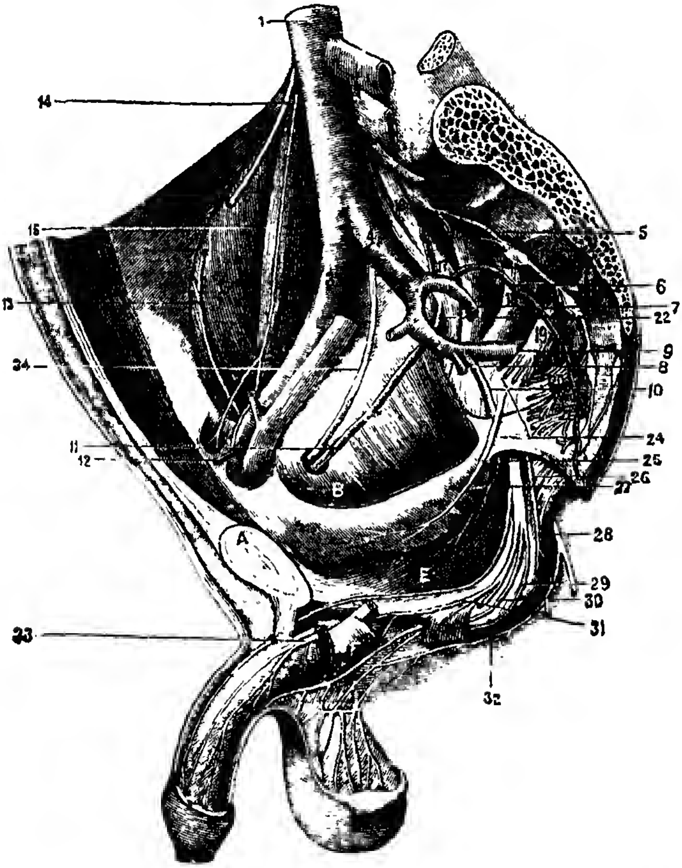


Fig. 40.—Right side of the interior of the male pelvis showing the branches of the hypogastric artery and the sacral and pudendal plexuses of nerves. (Modified from Testut).

A. Symphysis pubis.
B. Obturator externus.
C. Iliacus.
D. Psoas.
E. Levator ani.
F. Obturator internus.
1. Abdominal aorta.
2. Common iliac artery.
3. External iliac artery.
4. Hypogastric artery.
5. Ilio-lumbar artery.
6. Lateral sacral artery.
7. Superior gluteal artery.
8. Inferior vesical artery.
9. Inferior gluteal artery.
10. Internal pudendal artery.
11. Obturator artery.
12. Inferior epigastric artery.
13. Deep circumflex iliac artery.
14. Lateral femoral cutaneous nerve
15. Genito-femoral nerve.
16. Fifth lumbar nerve.
17. Lumbo-sacral nerve trunk.
18. Second sacral nerve.

19. Third sacral nerve.
20. Fourth sacral nerve.
21. Fifth sacral nerve.
22. Superior gluteal nerve.
23. Branch from the ganglion of the sympathetic to the sacral nerve.
24. Branches to the viscera.
25. Nerve to levator ani.
26. Hæmorrhoidal branch of pudendal nerve.
27. Pudendal nerve.
28. Inferior gluteal nerve.
29. Lateral posterior scrotal nerve.
30. Medial posterior scrotal nerve.
31. Nerve to bulb of the urethra.
32. Long perineal branch.
33. Dorsal nerve of penis.
34. Obturator nerve.

The **Middle Hæmorrhoidal Artery** usually arises in common with the inferior vesical. It supplies the muscular coat of the rectum and anastomoses with the superior and inferior hæmorrhoidal arteries.

Minute nerve filaments from the pelvic plexus accompany these visceral branches of the hypogastric artery.

The *middle hæmorrhoidal vein* begins in a venous plexus called the *hæmorrhoidal plexus*. This plexus consists of two parts, an internal and an external. The internal part will be seen in the submucous tissue of the rectum. The external part surrounds the muscular coat of the rectum and is drained at its upper part by the superior hæmorrhoidal vein and at its lower part by the inferior hæmorrhoidal vein. The intermediate part on of the plexus is drained by the middle hæmorrhoidal vein which opens into the hypogastric vein.

The **Obturator Artery** passes downwards and forwards along the lateral wall of the lesser pelvis to the obturator canal at the upper part of the obturator foramen. In the pelvis it gives off some *iliac branches* to the iliac fossa which supply the bone and the iliacus ; and a *pubic branch* which ascends along the back part of the os pubis and anastomoses with the pubic branch of the inferior epigastric artery. The further course and distribution of the obturator artery outside the pelvis will be seen during the dissection of the inferior extremity. The companion *vein* opens into the hypogastric vein.

The **Internal Pudendal Artery** (Internal pudic artery) passes downwards and lateralwards in front of the piriformis to the lower part of the greater sciatic foramen. It issues out of the pelvis between the piriformis and the coccygeus through the lower part of the greater sciatic foramen. It then crosses the ischial spine and enters the perineal space where it has already been examined. The companion *vein* opens into the hypogastric vein.

The **Inferior Gluteal Artery** (Sciatic artery) passes downwards to the lower part of the greater sciatic foramen, through

which it issues out of the pelvis between the piriformis and the coccygeus. Its companion *vein* opens into the hypogastric vein.

The **Ilio-lumbar Artery** passes upwards behind the obturator nerve, the external iliac vessels and the psoas major muscle. Behind the muscle it divides into a lumbar branch and an iliac branch. The *lumbar branch* supplies the psoas major and quadratus lumborum muscles and anastomoses with the lowest lumbar artery. It sends a *spinal branch* which passes through the intervertebral foramen between the fifth lumbar vertebra and the sacrum and supplies the cauda equina. The *iliac branch* supplies the ilium and the iliacus and anastomoses with the deep circumflex iliac artery near the crest of the ilium. The *ilio-lumbar vein* opens into the common iliac vein.

The **Lateral Sacral Artery** is either a single trunk or consists of two branches, an upper and a lower. It descends in front of the piriformis and the sacral nerves lateral to the anterior sacral foramina to the tip of the coccyx, where it anastomoses with the middle sacral artery. Opposite the anterior sacral foramina it gives off *spinal branches* which supply the contents of the sacral canal and pass out of the canal through the posterior sacral foramina to supply the muscles on the back of the sacrum. The companion *veins* open into the hypogastric vein.

The **Superior Gluteal Artery** (Gluteal artery) is the continuation of the posterior division of the hypogastric artery. It descends between the lumbo-sacral nerve trunk and the first sacral nerve and issues out of the pelvic cavity through the greater sciatic foramen above the piriformis. The companion *vein* opens into the hypogastric vein.

Middle Sacral Artery.—Its origin has been seen during the dissection of the abdominal cavity. It descends in front of the sacrum along the middle line to the tip of the coccyx, where it supplies the glomus coccygeum. On either side it anastomoses with twigs from the lateral sacral artery. Its companion *vein* opens into the left common iliac vein.

The **Superior Hæmorrhoidal Artery** is the terminal branch of the inferior mesenteric artery and supplies the mucous membrane of the rectum and anal canal. It descends between the two layers of the sigmoid mesocolon and on reaching the rectum divides into two branches. These branches descend one on either side of the rectum and give twigs which pierce the muscular coat and anastomose in the submucous coat with the middle and inferior hæmorrhoidal arteries. The *superior hæmorrhoidal*

vein drains the blood from the upper end of the hæmorrhoidal plexus and terminates in the inferior mesenteric vein.

The **Hypogastric Vein** (Internal iliac vein) is formed by tributaries corresponding to the branches of the hypogastric artery except the ilio-lumbar vein. It lies behind the hypogastric artery and joins the external iliac vein to form the common iliac vein.

Lymph Glands of the Lesser Pelvis.—Usually three groups of lymph glands are seen in the pelvis. (1) The *hypogastric glands* are found to surround the hypogastric vessels. Their afferents are derived from the area of distribution of the branches of the hypogastric artery. Their efferents pass to the common iliac lymph glands. (2) The *sacral glands* lie along the middle and lateral sacral vessels. Their afferents are derived from the rectum and posterior wall of the pelvis. Their efferents pass to the common iliac lymph glands. (3) The *rectal glands* are seen in relation to the superior hæmorrhoidal vein. Their afferents are derived from the upper part of the rectum and their efferents pass to the sacral lymph glands and to the preaortic lymph glands along the inferior mesenteric vessels.

The *pelvic diaphragm* or the *floor of the pelvis minor* should next be examined. It is formed by two muscles on each side. These are the levator ani and the coccygeus. The two levatores ani form the greater portion of the pelvic diaphragm. The two coccygei continue the plane of the pelvic diaphragm posterior to the levatores ani.

Levator Ani.—Its anterior fibres arise from the posterior surface of the quadrilateral part of the superior ramus of the os pubis ; the intermediate fibres arise from the white line of the pelvic fascia ; the posterior fibres arise from the pelvic surface of the ischial spine. The fibres are directed downwards and backwards to the floor of the pelvis. The muscle is inserted by its posterior fibres into (1) the side of the lower part of the coccyx, and into (2) a median raphe called the *ano-coccygeal raphe* extending from the coccyx to the anus. By its intermediate fibres it is inserted into (3) the side of the anal canal between the internal and external sphincter muscles blending with the longitudinal fibres of the gut ; between the two sphincter muscles they blend with the intermediate fibres of the opposite muscle and form a complete muscular sheet round the anal canal. By its anterior fibres it is inserted into (4) the sides of the prostate gland and (5) the central tendinous point of the perineum. The

anterior fibres which enclose the prostate are named the *levatores prostatæ*. The levator ani is supplied by a branch from the fourth sacral nerve and by a branch from the perineal nerve. *Action.*—This muscle together with the coccygeus forms the floor of the pelvis and hence supports the pelvic viscera. The fibres inserted round the anal canal pull that canal upwards and hence help defæcation.

The **Coccygeus** is situated behind the levator ani. It arises from the pelvic surface of the ischial spine and sacrospinous ligament. It is inserted into the side of the last piece of the sacrum and the upper part of the coccyx. It is supplied by a branch from the fourth and fifth sacral nerves. *Action.*—It forms the back part of the floor of the pelvis and pulls the coccyx forwards after defæcation.

Dissection. The student should now dissect the nerves and nerve plexuses of the pelvis. The portion of the sympathetic trunk in the pelvis and the pelvic plexuses of the sympathetic should be examined. The lumbo-sacral nerve trunk, the anterior divisions of the five sacral nerves and the coccygeal nerve, the formations of the sacral and pudendal plexuses and their branches should be studied.

The **Pelvic Portion of the Sympathic Trunk** is seen in front of the sacrum medial to the anterior sacral foramina and has upon it four or five ganglia. Lower down, the trunks of both sides converge and unite in front of the coccyx in a single minute ganglion called the *ganglion impar* or the *coccygeal ganglion. Grey rami communicantes* pass from the ganglia to the sacral and coccygeal nerves. Some filaments from the upper ganglia join the pelvic plexus and others accompany the middle sacral artery. From the ganglion impar, filaments are distributed to the glomus coccygeum.

The *glomus coccygeum* (coccygeal body) is a small body of the size of a small pea situated in front of the tip of the coccyx and consisting of fibrous tissue, filaments of the middle sacral artery and filaments of the sympathetic nerve. Its function is not known.

Sympathetic Plexuses in the Pelvis.—The *hypogastric plexus* is the continuation downwards of the aortic plexus and is joined by filaments from the lumbar ganglia. It is situated in front of the body of the last lumbar vertebra between the two common iliac arteries. Below it divides into two lateral portions called the *pelvic plexuses* which descend at the sides of the rectum.

They are joined by visceral branches from the third and fourth sacral nerves and by a few filaments from the upper two sacral ganglia of the sympathetic. Each pelvic plexus gives off branches to the pelvic viscera. These branches follow the course of the arteries of the pelvis and form subsidiary plexuses which supply (1) the rectum (*hæmorrhoidal plexus*); (2) the bladder, the ductus deferentes and the seminal vesicles (*vesical plexus*); (3) the prostate gland (*prostatic plexus*). From the prostatic plexus branches pass forwards beneath the pubic arch to the penis and are called the *cavernous nerves*.

Sacral Plexus.—The lumbo-sacral trunk, the anterior division of the first sacral nerve and the greater portions of the anterior divisions of the second and third sacral nerves unite to form a series of loops and constitute the sacral plexus. Near the lower part of the greater sciatic foramen the nerves which form the sacral plexus unite and form a flattened band. Branches issue from the surfaces of this band and the band itself continues its course and leaves the pelvis under the name of the sciatic nerve. The plexus lies on the piriformis muscle covered by the parietal pelvic fascia. The branches given off from the plexus are :

(1) The **Superior Gluteal Nerve** arises from the posterior aspect of the lumbo-sacral trunk and the first sacral nerve. It leaves the pelvis with the superior gluteal vessels through the upper part of the greater sciatic foramen above the piriformis.

(2) The **Inferior Gluteal Nerve** arises from the posterior aspect of the lumbo-sacral trunk and the first and second sacral nerves. It leaves the pelvis through the greater sciatic foramen below the piriformis.

(3) The **Posterior Femoral Cutaneous Nerve** (Small sciatic nerve) arises from the second and third sacral nerves and leaves the pelvis through the greater sciatic foramen below the piriformis.

(4) The **Nerve to the Obturator Internus** arises from the front aspect of the lumbo-sacral trunk and the first and second nerves. It leaves the pelvis through the greater sciatic foramen below the piriformis. After giving a branch to the gemellus superior it crosses the ischial spine, re-enters the pelvis through the lesser sciatic foramen and reaches the pelvic surface of the obturator internus.

(5) The **Nerve to the Quadratus Femoris** arises from the front aspect of the lumbo-sacral trunk and the first sacral nerve. It leaves the pelvis through the greater sciatic foramen below

the piriformis and supplies the gemellus inferior and quadratus femoris and also the hip-joint.

(6) The **Nerve to the Piriformis** arises from the second sacral nerve or from the first and second sacral nerves. It enters the piriformis on its anterior surface.

(7) The **Sciatic Nerve** (Great sciatic nerve) is the largest nerve in the body and is the continuation of the flattened band of the sacral plexus. It arises from the lumbo-sacral trunk and from the first three sacral nerves. It leaves the pelvis through the greater sciatic foramen below the piriformis.

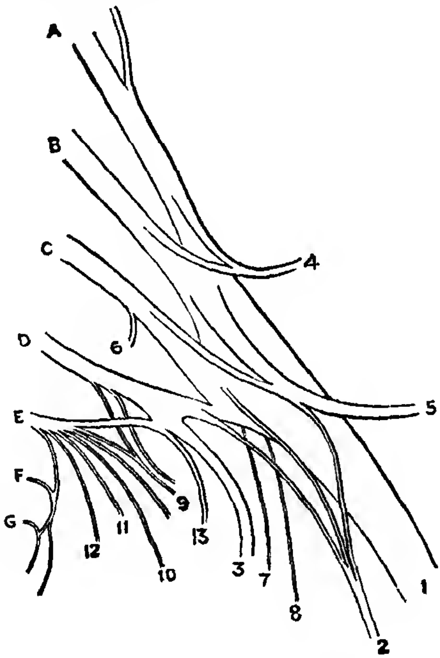


Fig. 41.—Diagram of the sacral, pudendal and coccygeal plexuses (after Ellis).

A. Lumbo-sacral nerve trunk.
B. First sacral nerve.
C. Second sacral nerve.
D. Third sacral nerve.
E. Fourth sacral nerve.
F. Fifth sacral nerve.
G. Coccygeal nerve
1. Great sciatic nerve.
2. Posterior femoral cutaneous nerve.
3. Pudendal nerve.
4. Superior gluteal nerve.
5. Inferior gluteal nerve.
6. Branch to piriformis.
7. Nerve to obturator internus.
8. Nerve to quadratus femoris.
9. Visceral branches of third and fourth sacral nerves.
10. Branch to levator ani.
11. Branch to coccygeus.
12. Perineal branch of fourth sacral nerve.
13. Perforating cutaneous branch.

The **Pudendal Plexus** is not sharply demarcated from the sacral plexus. In fact the sacral and pudendal plexuses were formerly described as parts of one and the same plexus viz., the sacral plexus. It is formed by the remaining portions of the anterior divisions of the second, third, together with the greater portion of the anterior division of the fourth sacral nerves. The branches given off from the pudendal plexus are :—

(1) The **Visceral Branches** (Parasympathetic fibres) arise from the second, third and fourth sacral nerves. They communicate with the pelvic plexuses of the sympathetic and supply the bladder and rectum.

(2) The **Perforating Cutaneous Nerve** arises from the posterior aspects of the second and third sacral nerves. It pierces the sacrotuberous ligament and appears at the lower border of the gluteus maximus.

(3) The **Pudendal Nerve** (Pudic nerve) arises from the second, third and fourth sacral nerves. It leaves the pelvis through the greater sciatic foramen.

(4) The **Muscular Branches** arise from the fourth sacral nerve and supply the levator ani, the coccygeus and the sphincter ani externus.

The **Coccygeal Plexus** is formed by a filament from the anterior division of the fourth sacral nerve joining the anterior division of the fifth sacral nerve and the coccygeal nerve. From this plexus a few filaments, the *anococcygeal nerves*, proceed to perforate the sacrotuberous ligament and supply the skin of the coccygeal region. Twigs from the fifth sacral nerve supply the coccygeus.

Dissection. Detach the crura of the penis from the pubic bones. Remove the rectum and the bladder together with the prostate gland and penis in one mass by a circular cut around those structures. The vesiculæ seminales and the ductus deferentes will remain attached to the prostate by the ejaculatory ducts and the divided ureters will remain attached to the bladder. Two muscles in the pelvic wall, the obturator internus and the piriformis, are now fully exposed and require to be studied.

The **Obturator Internus** arises (1) from the inner surface of the inferior rami of the ischium and os pubis around the obturator foramen, (2) from the medial part of the pelvic surface of the obturator membrane, (3) from the pelvic surface of the hip bone behind the obturator foramen as far as the greater sciatic notch and (4) from the lateral surface of the obturator fascia to a small

extent. From these origins the fibres converge to a tendon which passes out of the pelvis through the lesser sciatic foramen. In the gluteal region this tendon receives the insertion of the gemelli muscles and becomes inserted into the front part of the medial surface of the greater trochanter of the femur. The margin of the lesser sciatic notch is covered with cartilage which presents two or three ridges ; these ridges correspond with the furrows which are seen on the surface of the tendon as it passes through the cartilage covered notch. A bursa separates the tendon from the cartilage. A special branch from the sacral plexus supplies the obturator internus muscle. *Action*.—In the erect posture this muscle rotates the thigh outwards ; when the hip joint is flexed it abducts the thigh.

The **Piriformis** arises (1) from the sacrum by three slips which are attached to the portions of bone between the upper four anterior sacral foramina and from the grooves passing lateralwards from these foramina, (2) from the portion of the hip bone where it forms the upper border of the greater sciatic notch, and (3) from the sacrotuberous ligament. It comes out of the pelvis through the greater sciatic foramen and is inserted into the upper border of the greater trochanter of the femur. It is supplied by branches from the first and second sacral nerves. Its *actions* are like those of the obturator internus.

Dissection. Remove the obturator internus muscle from the surface of the membrane closing the obturator foramen on the left side.

The **Obturator Membrane** is an oval membrane attached to the circumference of the obturator foramen except at its upper part where it stretches over the obturator groove and converts the groove into a canal, the *obturator canal*, through which the obturator vessels and nerve pass. The membrane gives origin to the obturator internus muscle on its pelvic surface and to the obturator externus muscle on its lateral surface.

Direction. Distend the bladder by a blow pipe through one of the ureters and examine the coats.

Structure of the Bladder.—The wall of the bladder consists of four coats, serous, muscular, submucous and mucous.

The *serous coat* is derived from the peritoneum. It provides only a partial covering and has been described.

The *muscular coat* consists of three layers : (*a*) the *external layer*, consisting of longitudinal fibres which arise from the posterior surface of the quadrilateral part of the superior ramus of the

os pubis and the base of the prostate gland close by. They ascend in a longitudinal manner over the inferior surface and the vertex of the bladder and descend over its superior surface and fundus to the base of the prostate to which they are attached. At the sides of the bladder the fibres pass obliquely. This external layer is called the *detrusor urinæ* muscle. (*b*) The *middle layer* consists of circular fibres which are mostly arranged obliquely round the bladder. These circular fibres are specially developed around the internal urethral orifice forming the *sphincter vesicæ*. (*c*) The internal layer consists of longitudinal fibres which are thinly developed.

The *submucous coat* consists of areolar tissue in which the vessels and nerves ramify prior to their entrance into the mucous membrane.

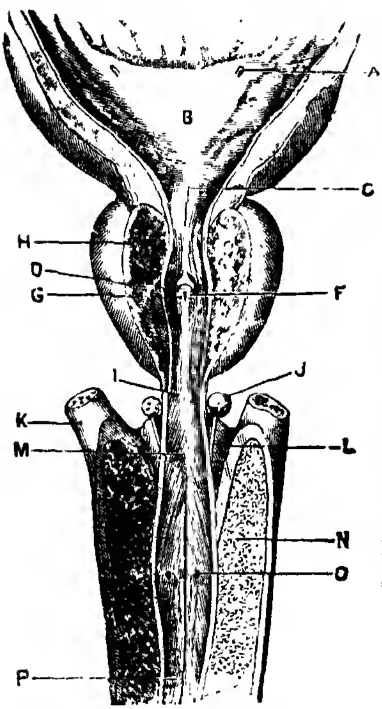
Dissection. Open the bladder by making an incision from the vertex along the inferior surface to the middle of the base of the prostate gland. Enlarge the incision backwards along the superior surface of the bladder.

The *mucous membrane* is thrown into irregular folds or *rugæ* except over a triangular area, the trigonum vesicæ. These folds disappear during the distension of the viscus.

Interior of the Bladder.—Within the bladder certain special parts are seen. The *internal urethral orifice* is situated at the most dependent part of the bladder at the base of the prostate gland. The mucous membrane behind the internal urethral orifice is slightly raised by a thickening of the underlying submucous tissue. This elevation is called *uvula vesicæ*. The *orifices of the ureters* are slit-like openings situated about an inch behind the internal urethral orifice at the postero-lateral angles of the bladder. Pass a bristle and note the oblique course of the ureters through the wall of the bladder for nearly three fourths of an inch. Between the orifices of the ureters is a transverse elevation of the mucous membrane produced by a subjacent band of muscular fibres and is called the *torus uretericus*. This elevation is continued beyond the opening of the ureter and is produced by the portion of the ureter traversing the wall of the bladder and is named the *plica ureterica*. The *trigonum vesicæ* is the triangular space, the three angles of which are formed by the three orifices in the interior of the bladder, viz., the internal urethral orifice and the two orifices of the ureters. Its apex is formed by the internal urethral orifice ; its base, by the torus uretericus ; its sides by two lines joining the orifices of the ureters

with the internal urethral orifice. The mucous membrane of the trigone is smooth and never thrown into folds as the submucous tissue here is not lax and the mucous membrane is firmly attached to the muscular coat.

Prostate Gland.—Next clean the prostate gland. Remove the fascial investment which envelopes it and forms its *sheath.* The *prostatic plexus of veins* is now exposed which is placed in the sheath and also between the sheath and the capsule of the gland. This plexus communicates with the vesical plexus of veins which covers the base of the prostate gland and the lower part of the bladder, and also with the pudendal plexus. Clean this venous plexus and expose the *fibrous capsule* which surrounds the gland and is quite distinct from its sheath. Note that the urethra emerges from the prostate gland on the anterior surface close to the apex of the gland. The ejaculatory ducts pierce the prostate through a depression which is near the upper border



A Opening of ureter
B. Trigonum vesicæ
C Uvula vesicæ.
D. Urethral crest.
F. Prostatic utricle.
G. Opening of ejaculatory duct
H. Section of prostate.
I. Membranous part of urethra.
J. Bulbo-urethral gland.
K. Crus penis.
L. Portion of the bulb.
M. Commencement of bulbous portion.
N. Section of crus penis.
O. Opening of duct of bulbo-urethral gland.
P. Cavernous portion of urethra.

Fig. 42. The bulbous, membranous and prostatic urethra and portion of the bladder laid open from above (after Wilson).

of the posterior surface. This depression divides the posterior surface into an upper small portion called the *middle lobe* of the prostate, and a lower large portion which is subdivided by an indistinct median groove ; the groove demarcates this portion into the two *lateral lobes*. Trace the *ejaculatory ducts* to their points of entrance into the posterior part of the base of the prostate. These ducts pass downwards and forwards through the substance of the prostate to open into the floor of the urethra. These openings will be seen when the urethra is opened up. Structurally the prostate gland consists of unstriped muscular fibres and gla dular tissue.

Dissection. Open up the urethra from the internal urethral orifice to the external urethral orifice along the anterior surface of the prostate gland and along the dorsal surface of the penis between its two corpora cavernosa.

The **Urethra** extends from the internal urethral orifice in the bladder to the external urethral orifice at the end of the glans penis. Its length is variable, being usually eight to nine inches (20 to 22 cm.). It is subdivided into three portions, the prostatic, the membranous, and the cavernous.

The *prostatic portion* is surrounded by the prostate gland. It is about one inch and a quarter in length and the widest and most dilatable part of the urethra. From above down it is spindle-shaped being dilated in the midd'e and narrow at either end. It is nearer the anterior than the posterior surface of the prostate gland. On its posterior wall or floor is a longitudinal ridge, called the *urethral crest* (verumontanum), formed by a raising up of the mucous membrane. The crest begins a little below the internal urethral orifice and is about three-fourths of an inch in length. The most prominent part of the crest is called the *colliculus seminalis*. On either side of the crest is a depression called the *prostatic sinus* on the floor of which minute orifices are seen. These are the openings of the ducts of the prostate gland. Below the colliculus seminalis is the opening of a blind pouch called the *prostatic utricle* (sinus pecularis). This pouch is directed upwards and backwards in the substance of the prostate beneath its middle lobe and is about one-fourth to half an inch in length. Just within the lateral margins of the opening of this pouch are seen the minute slit-like orifices of the ejaculatory ducts. The prostatic pouch corresponds developmentally to the uterus and vagina in the female and is thus called uterus masculinus.

The *membranous portion* extends from the prostate gland to the commencement of the cavernous portion of the urethra. It is about three-fourths of an inch in length and is the shortest and narrowest portion of the urethra (with the exception of the external urethral orifice). It passes downwards and forwards and lies between the two layers of the urogenital diaphragm both of which it pierces. It is completely surrounded by the sphincter urethræ membranaceæ.

The *cavernous portion* (spongy portion) is about six inches in length and extends from the inferior fascia of the urogenital diaphragm to the external urethral orifice. It traverses the corpus cavernosum urethræ and presents two dilatations, one within the bulb, and another in the glans penis where the dilatation is called the *fossa navicularis*. The cavernous portion of the urethra at first passes forwards and upwards to the front of the symphysis pubis and then bends downwards and forwards. The minute openings of the ducts of the bulbo-urethral glands are seen in this portion of the urethra about an inch in front of the inferior fascia of the urogenital diaphragm.

The *external urethral orifice* is a vertical slit and is the narrowest part of the canal.

The *mucous membrane of the urethra* presents the orifices of numerous mucous glands, called the *urethral glands*; these are specially seen in the cavernous portion. Besides these orifices many minute pit-like recesses called *urethral lacunæ* are seen. One of these is bigger than the rest and is situated in the roof of the fossa navicularis. It is called the *lacuna magna*.

Structure of the Rectum and the Anal Canal.—The rectum and the anal canal have the same coats as the colon. The *serous coat* is formed by peritoneum and has been noted. The anal canal which is devoid of peritoneum receives instead a prolongation of the visceral layer of the pelvic fascia. In the *muscular coat*, the longitudinal muscular fibres are spread over the whole gut and not collected into three bands as in the colon. In the anal canal the levator ani muscle is inserted on the longitudinal muscle fibres between the internal and external sphincters of the anus. The circular muscular fibres form a thick layer and are specially thickened at the lower part of the anal canal to form the *internal sphincter ani*. The *submucous coat* is loose and contains the blood vessels including the hæmorrhoidal venous plexus. The *mucous membrane* of the rectum is thrown into longitudinal folds which disappear during the distension of the

gut. Besides these it presents three transverse folds called *plicæ transversales recti* (Houston's valves). These are permanent folds of the mucous membrane and submucous tissue which contain circular muscular fibres. One of them is situated along the right side of the rectum and the other two on the left side corresponding to the three lateral flexures of the rectum. The mucous membrane of the anal canal in its upper half is thrown into longitudinal folds called *rectal columns* (columns of Morgagni). The lower ends of these columns are connected by semilunar folds of mucous membrane called *anal valves*. Outside each valve is a small pouch called the *rectal sinus*. The lower half of the anal canal is lined by cuticle prolonged from the margin of the anus. At the junction of the cuticle and the mucous membrane is a lighter coloured line called the *white line*.

ARTICULATIONS OF THE PELVIS

Directions. The student should now study the articulations of the pelvis. These include (1) the lumbo-sacral, (2) the sacro-coccygeal, (3) the coccygeal, (4) the sacro-iliac and (5) the pubic articulations.

Lumbo-sacral Articulation.—The last lumbar vertebra articulates with the sacrum and the ligaments which connect together two contiguous typical vertebræ (see Articulations of the Trunk) are all seen in the lumbo-sacral joint. Thus (1, 2) the *anterior* and *posterior longitudinal ligaments* (anterior and posterior common ligaments) are continued over the anterior and posterior surfaces of the body of the last lumbar and first sacral vertebræ. (3) The *ligamenta flava* (ligamenta subflava) extends from the anterior aspect of the inferior border of the laminæ of the last lumbar vertebra to the posterior aspect of the superior border of the laminæ of the first sacral vertebra. (4) The *articular capsules* surround the inferior articular processes of the last lumbar and the superior articular processes of the first sacral vertebra. Each capsule is lined by a synovial stratum. (5) The *interspinal ligament* lies between the spinous processes of the last lumbar and the first sacral vertebræ; the attachment extending from the root to the tip of the spinous process. (6) The *supraspinal ligament* connects the tips of the spinous processes of the same vertebræ. Two other ligaments are found in addition in this joint. These are the lumbo-sacral and ilio-lumbar liga-

ments. (7) The *lumbo-sacral ligament* is attached above to the lower border of the transverse process of the last lumbar vertebra and below to the ala of the sacrum. (8) The *ilio-lumbar ligament*

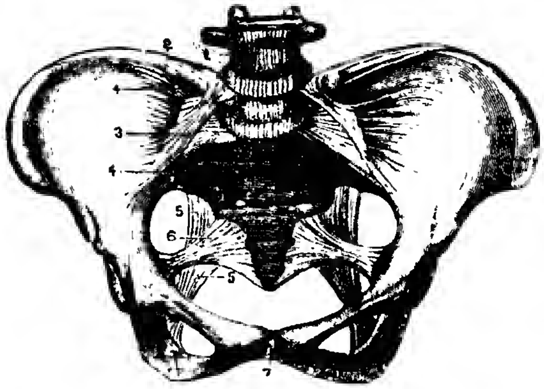


Fig. 43.—Ligaments of the pelvis (Sappey).

1. Anterior longitudinal ligament of vertebra.
2. Ilio-lumbar ligament.
3. Lumbo-sacral ligament.
4. Anterior sacro-iliac ligament.
5. Sacro-tuberous ligament.
6. Sacro-spinous ligament.
7. Fibro-cartilage of symphysis pubis.

extends transversely from the tip of the transverse process of the last lumbar vertebra to the inner lip of the iliac crest. The articulation between the bodies of the last lumbar and the first sacral vertebræ is an amphiarthrosis, *i.e.*, slightly movable joint, and has an intervertebral *fibro-cartilage* between them. This fibro-cartilaginous disc is very thick anteriorly.

The **Sacro-coccygeal Articulation** is also an amphiarthrodial joint. The articulating surfaces are united by an intervertebral *fibro-cartilage*. The joint has an *anterior sacro-coccygeal ligament* which connects in front. and a *posterior sacro-coccygeal ligament* which connects behind, the bodies of the last sacral and first coccygeal vertebræ, and the *lateral sacro-coccygeal ligaments* which connect the lateral angles of the sacrum to the transverse processes of the coccyx.

Coccygeal Articulations. When the different segments of the coccyx are movable, fibro-cartilaginous discs are interposed between the separate segments which are connected anteriorly and posteriorly by anterior and posterior ligaments.

The **Sacro-iliac Articulation** is an amphiarthrodial joint.

It is formed by the auricular surfaces of the sacrum and ilium and the ligaments connecting them are :—(1) The *anterior sacro-iliac ligament* which connects the anterior aspects of the auricular surfaces of the sacrum and ilium, (2) the *posterior sacro-iliac ligament* which extends from the rough area on the ilium behind its auricular surface to the first, second and third transverse tubercles on the posterior surface of the sacrum. The upper portion of the ligament passing transversely to the first and second transverse tubercles is called the *short posterior sacro-iliac ligament.* The lower portion of the ligament passing obliquely from the posterior superior iliac spine to the third transverse tubercle on the back of the sacrum is called the *long posterior sacro-iliac ligament.* (3) The *interosseous sacro-iliac ligament* lies covered by the posterior sacroiliac ligament. It consists of strong, short fibres connecting the rough surfaces of the ilium and sacrum behind the auricular surfaces. (4) The *sacro-tuberous ligament* (Great Sacrosciatic ligament) is attached above to the posterior inferior iliac spine, to the third, fourth, and fifth transverse tubercles of the sacrum and to the lateral margins of the sacrum and coccyx. From this broad attachment it passes downwards, forwards and lateralwards, becomes narrow and thickened in the middle and is again expanded at its attachment below to the medial border of the ischial tuberosity. From this attachment it is prolonged upwards as a sickle-shaped process called the *falciform process* to the free margin of which the obturator fascia is attached. (5) The *sacro-spinous ligament* (Small Sacro-sciatic ligament) is triangular and is attached by its apex to the spine of the ischium and by its base to the lateral margins of the sacrum and coccyx in front of the sacro-tuberous ligament.

The **Symphysis Pubis** is an amphiarthrosis. The ligaments of the joint are :—(1) The *anterior pubic ligament* which stretches across the front aspect of the joint. (2) The *posterior pubic ligament* consists of scattered fibres lying on the posterior aspect of the joint. (3) The *superior pubic ligament* passes between the two pubic bones superiorly. (4) The *arcuate pubic ligament* (subpubic ligament) connects together the two pubic bones inferiorly. Above it is attached to the interpubic fibrocartilage and below by its concave margin it forms the upper boundary of the foramen which transmits the dorsal vein of the penis. A *fibrocartilaginous disc* is interposed between the cartilage-coated opposed surfaces of the pubic bones. A small synovial cavity is usually found inside this fibro-cartilage.

LESSER PELVIS IN THE FEMALE

Position and Relations of the Viscera.—The bladder with the urethra occupies the front part of the pelvic cavity while the rectum is situated behind ; between the bladder in front and the rectum behind are the uterus and the vagina and stretching laterally from the uterus to the side wall of the lesser pelvis are the broad ligaments of the uterus with certain structures enclosed between their layers. The loop of the sigmoid colon overhangs the uterus and the bladder.

The **Peritoneum** as it lines the posterior wall of the lesser pelvis completely encircles the sigmoid colon and holds it to the posterior pelvic wall by a loose fold called the sigmoid mesocolon. Then it covers the upper third of the rectum both in front and at the sides. It then covers the anterior surface of the middle third of the rectum and is reflected thence to the upper part of the posterior surface of the vagina. On either side of the rectum a peritoneal fossa is seen called the *pararectal fossa*. From the posterior surface of the vagina the peritoneum is continued on to the cervix and the posterior intestinal surface of the uterus and the upper two-thirds of its anterior or vesical surface. The deep pouch of peritoneum lying between the rectum behind and the uterus and posterior vaginal wall in front is called the *recto-uterine excavation* (pouch of Douglas). It is bounded on either side by a fold of peritoneum called the *sacro-uterine* or *recto-uterine fold* which corresponds to the sacro-genital fold in the male. The sacro-uterine folds contain unstriped muscular fibres. These two folds become continuous with each other behind the cervix of the uterus producing a transverse ridge in that situation called the *torus uterinus*. After lining the upper two-thirds of the anterior surface of the uterus the peritoneum is reflected to the superior surface of the bladder forming a shallow pouch called the *vesico-uterine excavation*. This is bounded on either side by a fold of peritoneum extending from the postero-lateral angles of the bladder and called the *vesico-uterine fold* (posterior false ligament of the bladder). From either side of the uterus the peritoneum passes to the side wall of the pelvis as a double fold called the *broad ligament of the uterus* which encloses between its two layers the uterine appendages. From the superior surface of the bladder the peritoneum is reflected to the side wall of the pelvis forming the *lateral false ligaments of the bladder*. The *paravesical fossa* is seen on either side of the

bladder as in the male. From the bladder the peritoneum passes on to the posterior aspect of the anterior abdominal wall as in the male.

Peritoneal Fossæ.—These are: (1) the pararectal fossa, (2) paravesical fossa, (3) vesico-uterine excavation, (4) recto-uterine excavation, (5) ovarian fossa, on which the ovary lies and is situated between the obliterated hypogastric artery and ureter.

The *broad ligament of the uterus* extends from the side of the uterus to the side wall of the pelvis ; the two ligaments together with the uterus complete the division of the female pelvis into two parts—the anterior, containing the bladder ; and the posterior, the rectum. The structures enclosed between its two layers which may now be identified are : (1) the uterine tube lying along its superior border ; (2) the ovary and its ligament below and behind the uterine tube, (3) the round ligament placed below and in front of the uterine tube. Besides these the other structures enclosed within the layers of the broad ligament which will be identified later on are :—(4) the epoophoron and paroophoron ; (5) the uterine and ovarian vessels ; (6) nerve filaments; and (7) connective tissue and unstriped muscle fibres. The portion of the broad ligament between the ovary and the uterine tube is called the *mesosalpinx.* The portion of it that extends backwards to the ovary is called the *mesovarium.*

The **Pelvic Fascia** is now to be exposed on the right side by reflecting the peritoneum together with the broad ligament of the uterus. The parietal layer has an arrangement similar to that in the male. The vesical layer and the rectal layer of the visceral portion have the same arrangement as in the male. The recto-vesical layer of the male pelvis is represented by the recto-vaginal layer which is pierced by the vagina in front of the rectum and is prolonged as a sheath on the vaginal wall.

The **Rectum** corresponds to that in the male with this difference that it is in relation anteriorly with the recto-uterine excavation and vagina.

The **Bladder**, in the female, is in relation posteriorly with the uterus and the anterior wall of the vagina. The vesico-uterine excavation separates it from the body of the uterus ; below the excavation it is in contact with the cervix uteri and vagina being separated only by areolar tissue.

The prostate gland, the ductus deferentes and the vesiculæ seminales are absent in the female.

Ureters. The pelvic portion of the ureter is longer in the female. At the upper part of its course it has the same relations as in the male but in the lower part of the course it passes beneath

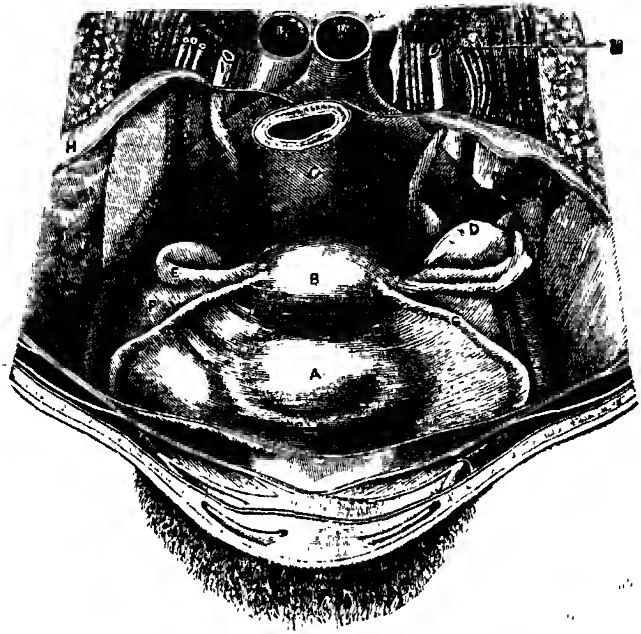


Fig. 44.—Female pelvic viscera from above. The uterine tube and ovary have been raised above their proper position (after Testut).

A. Bladder.
B. Uterus.
C. Sigmoid colon.
D. Ovary.
E. Uterine tube.
F. Broad ligament.
G. Round ligament.
H. Peritoneum.
I. Ureter.
J Psoas major muscle.
K. Aorta.
L. Vena cava inferior.
M. Ovarian vessels.

the lower border of the broad ligament to the side of the upper part of the vagina and before opening into the posterio-lateral angle of the bladder lies in front of the upper part of the vagina. It is crossed by the uterine artery.

The **Urethra** in the female is about an inch and a half (4cm.) in length. It passes downwards and forwards, pierces the urogenital diaphragm and opens into the vestibule. It lies against the anterior vaginal wall throughout the whole of its length.

Dissection. Divide the peritoneum at the bottom of the vesico-uterine excavation by a transverse incision and draw the bladder forwards from the anterior surface of the neck of the uterus and the vagina.

The **Uterus** receives the impregnated ovum and retains the developing fœtus. The description given here is of the adult virgin uterus. It is placed above the vagina between the bladder and the rectum. It is piriform in shape, about three inches (7.5 cm.) in length, two inches (5 cm.) in breadth and one inch (2.5 cm.) in thickness. It is divided into a fundus, a body and a cervix or neck.

The **fundus** is the rounded portion lying above the level of the uterine tubes. It is entirely covered by peritoneum and is directed upwards and forwards.

The **body** is broad above and narrow below. It has an anterior or vesical and a posterior or intestinal surface and two lateral borders. The *anterior surface* is slightly convex and is covered by peritoneum. The *posterior surface* is markedly convex and is also covered by peritoneum. Each *lateral border* is joined above by the uterine tube ; a little below is attached the round ligament in front and the ligament of the ovary behind.

The **cervix** or neck is about an inch (2.5 cm.) in length and marked off from the body by a slight constriction on the surface which is called the *isthmus*. The cervix lies partly above the vagina and partly inside the vagina. The portion lying above the vagina is called the *supravaginal portion* and is covered in front and at the sides by cellular tissue called the *parametrium ;* and the part projecting into the vagina is called the *vaginal portion*. The *anterior surface* of the cervix is not covered by peritoneum and is in relation with the fundus of the bladder ; the *posterior surface* is entirely covered by peritoneum.

The *ligaments of the uterus* are : (1) the anterior ligament which consists of the vesico-uterine fold ; (2) the posterior ligament which consists of the recto-vaginal fold ; (3) the two round ligaments ; and (4) the two lateral or broad ligaments.

The **Vagina** is the passage extending from the vulva to the uterus and is placed between the bladder in front and the rectum behind. Its length is about three inches (7.5 cm.). It is not a patent canal ; its walls lie in apposition. It is constricted at either end and slightly wider in the middle. Its upper end is attached around the cervix of the uterus and if the finger is passed up the vagina the hard projecting end of the cervix can be

felt. The deep recess felt between the posterior vaginal wall and the cervix is called the *posterior fornix*. The shallower recess felt between the cervix and anterior vaginal wall is called the *anterior fornix*, and the recesses felt between the lateral vaginal wall and the cervix are called the *lateral fornices*. *Anteriorly* the vagina is in relation with the base of the bladder and the urethra while *posteriorly* from above downwards it is in relation with the recto-uterine excavation, the rectum and the perineal body. Laterally it is supported by the levator ani muscles and the ureters lie in contact with it at its upper part.

The **Uterine Tubes** (Fallopian tubes) are two in number and serve the purpose of conducting the ova from the ovary to the uterine cavity. Each tube is about four inches (10 cm.) in length and occupies the upper border of the broad ligament. It runs first lateralwards till it reaches the lower extremity of the ovary; it then passes upwards to reach the superior extremity of the ovary; finally it turns downwards and comes in relation with the posterior border and medial surface of the ovary. It consists of four portions, the pars uterina tubæ, the isthmus, the ampulla, and the infundibulum. The *pars uterina tubæ* is the portion that passes through the wall of the uterus and opens into the uterine cavity. The *isthmus* is the constricted portion passing lateralwards from the body of the uterus and forms nearly one-third of the length of the tube. The *ampulla* is the dilated lateral half of the tube and ends laterally in a funnel-shaped expansion called the *infundibulum*, the base of which is surrounded by a number of fringe-like processes called the *fimbriæ*. One of these fimbriœ is longer than the others and is attached to the tubal extremity of the ovary. It is called the *ovarian fimbria*. The minute orifice by which the uterine tube communicates at its lateral end with the peritoneal cavity is called the *ostium abdominale*.

The **Ovaries** correspond to the testes in the male. They are two oval shaped solid bodies placed in the posterior part of of the broad ligament below the uterine tubes. The ovary is displaced during pregnancy and it is believed that it never gets back its original position. The description given here is what is seen in the nulliparous female. Each organ occupies a shallow peritoneal fossa (*ovarian fossa*) below the external iliac vessels and in front of the ureter and uterine artery. The surface of the ovary is smooth before puberty but after that period it becomes puckered due to the escape of the ova by the bursting

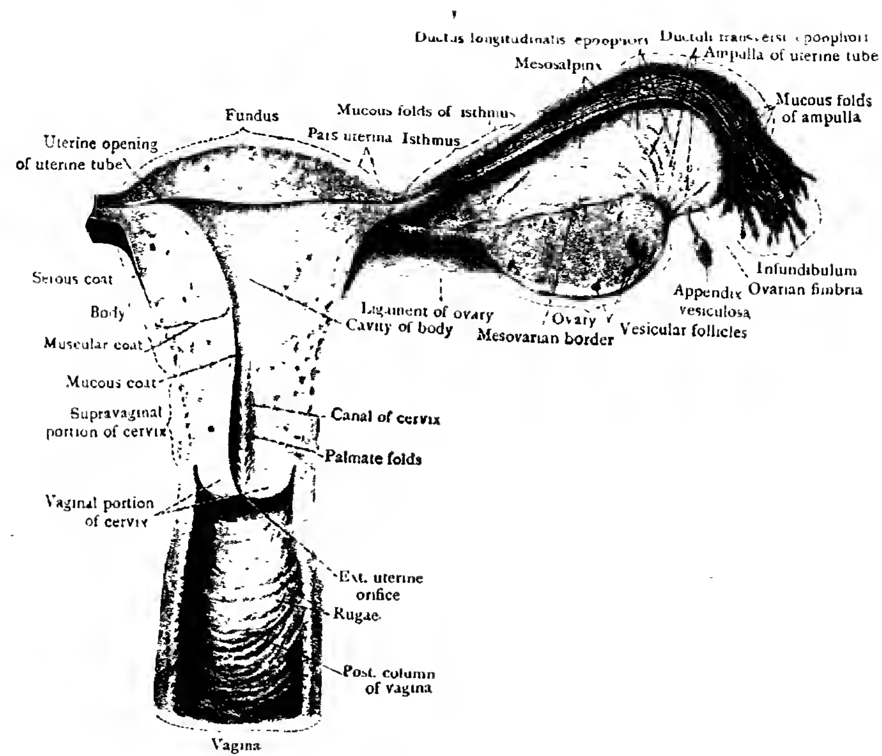


Fig. 45.—The uterus, uterine tubes, ovary and vagina (Sobotta).

To face P. 130.

of the ovarian follicles. It presents for examination two surfaces, two borders and two extremities. The *medial surface* is partly covered by the uterine tube. The *lateral surface* lies against the ovarian fossa. The *anterior border* or *hilum* is straight and is attached to the broad ligament by the mesovarium. Through it the blood vessels and nerves of the ovary pass. The *posterior border* is convex and free. The *upper* or *tubal extremity* is attached to the fimbriated end of the uterine tube by the ovarian fimbria. The *lower* or *uterine extremity* is connected with the side of the uterus by the ligament of the ovary. In the fœtus, the ovaries are lodged in the abdominal cavity near the kidneys and after birth they are seen in the lesser pelvis.

The **Round Ligament** is a fibro-muscular band which proceeds from the body of the uterus in front of and just below the attachment of the uterine tube. It runs lateralwards and forwards between the layers of the broad ligament and enters the abdominal inguinal ring by turning lateral to the inferior epigastric artery. It traverses the inguinal canal, issues out of the subcutaneous inguinal ring and is ultimately lost in the labium majus.

Blood-vessels.—Three vessels peculiar to the female pelvis viz., the ovarian, the uterine and the vaginal arteries require to be studied. Reflect the peritoneum and trace these vessels on the left side.

Ovarian Artery.—Its origin from the abdominal aorta and its course up to the brim of the lesser pelvis has been described. Crossing the external iliac vessels it enters between the two layers of the broad ligament and passes to the anterior border of ovary with a tortuous course. Here it gives off many small twigs which enter the ovary. It also sends twigs to the uterine tube and the round ligament and anastomoses with the branches of the uterine artery. The *ovarian veins* emerging from the anterior border of the ovary form a tortuous plexus called the *pampiniform plexus* between the two layers of the broad ligament. Two veins emerge from the plexus and accompany the ovarian artery and ultimately unite to form a single vein, which opens on the right side into the inferior vena cava and on the left side into the left renal vein.

The **Uterine Artery** is a branch of the anterior division of the hypogastric artery. It proceeds medialwards along the lower border of the broad ligament to the cervix and sends several branches to the vagina. It then ascends between the two layers

of the broad ligament in a tortuous manner along the side of the uterus giving several branches to it. It also gives twigs to the uterine tube, the round ligament and the ovary and anastomoses near its termination with branches of the ovarian artery. The *uterine veins* begin in a plexus at the side of the uterus called the *uterine venous plexus* situated between the two layers of the broad ligament. They terminate after a tortuous course in the hypogastric vein.

The **Vaginal Artery** arises from the anterior division of the hypogastric artery. It descends on the vagina and supplies it. It also sends twigs to the base of the bladder and to the rectum and anastomoses with the vaginal branches of the uterine artery. The *vaginal veins* begin in a plexus situated around the vagina called the *vaginal venous plexus* and terminate in the hypogastric vein.

Nerves.—The following three plexuses of nerves require to be specially examined in the female pelvis :—(1) The *uterine plexus,* which is derived from the pelvic plexus and accompanies the uterine artery to the uterus ; (2) the *vaginal plexus* which is derived from the pelvic plexus and accompanies the vaginal artery to the vagina ; (3) the *ovarian plexus* which is derived from the aortic and renal plexuses and accompanies the ovarian artery to the ovary.

Dissection. Divide the blood vessels and nerves passing to the viscera and remove the viscera in one mass by carrying the knife circularly around them. Separate the bladder and the urethra from the mass and open up the bladder along the middle line of its inferior surface and extend the incision along the ventral wall of the urethra.

Structure of the Bladder and Urethra.—The bladder has the same structure as in the male. The urethra presents a muscular coat consisting of an external layer of longitudinal and an internal layer of circular fibres. The submucous coat connects the muscular with the mucous coat. The mucous membrane is thrown into longitudinal folds.

Dissection. Next separate the uterus and vagina together with the broad ligaments from the rectum.

The **Epoophoron** (Parovarium or organ of Rosenmuller) lies between the ovary and the uterine tube and consists of a few short vertical tubules and a horizontal tubule. It corresponds to the lobules and the duct of the epididymis. Hold the broad ligament to the light and stretch the portion of it lying between the ovary and the uterine tube. A number of verti-

cal tubules called the *ductuli transversi* will be seen radiating from the ovary towards the uterine tube. Joining the bases of these tubules a single tubule will be seen ending blindly near the uterus. This is called the *ductus longitudinalis epoophori* (duct of Gartner). Laterally it ends sometimes in one or more vesicles called the *appendices vesiculosæ* (hydatids of Morgagni).

The **paroophoron** consists of a few scattered tubules seen between the epoophoron and the body of the uterus.

Structure of the Uterine Tube.—Three coats enter into the formation of the uterine tube—serous, muscular, and mucous. The *serous coat* is formed by the peritoneum of the broad ligament. The *muscular coat* consists of an external layer of longitudinal and an internal layer of circular fibres. The *mucous membrane* is thrown into longitudinal folds and will be seen by opening up the infundibulum and the ampulla of the tube.

Structure of the Vagina.—Open up the vagina along its sides. The wall of the vagina consists of a muscular coat, a layer of erectile tissue, and a mucous coat. The *muscular coat* is the outermost and formed by an external layer of longitudinal and an internal layer of circular unstriped muscular fibres. The lower end of the vagina is encircled by circular muscular fibres, the bulbo-cavernosus. The erectile tissue consists of a layer of connective tissue in which are seen a venous plexus and unstriped muscular fibres. The *mucous membrane* is the innermost coat and presents two longitudinal folds, one on the anterior and the other on the posterior wall. These folds are called the *columnæ rugarum* from each side of which transverse folds are given off lateralwards.

In the vaginal portion of the cervix observe that at its lower end is an opening called the *external uterine orifice* (Os uteri externum) by means of which the uterus communicates with the vagina. This orifice is bounded by two thick lips; of which the anterior one is the thicker while the posterior one is the longer. The sulcus between the vaginal portion of the cervix and the vaginal wall is called the *fornix* of the vagina. It is formed by the mucous membrane of the vagina being reflected on to the cervix. Its subdivision into an anterior, a posterior and two lateral portions has been already described (p. 130).

Dissection. Divide the uterus by a coronal section by inserting the knife over the fundus between the uterine tubes and carrying it along the lateral borders of the uterus to the end of the cervix. The uterus is thus divided into two halves, an

anterior and a posterior, and the whole of uterine cavity is exposed.

The *cavity of the body of the uterus* is triangular in shape ; its base is at the fundus and the apex communicates with the cavity of the cervix by a narrow orifice called the *internal uterine orifice* (Os uteri internum). At each upper and lateral angle is the minute orifice of the uterine tube. The *cavity of the cervix* is wider in the middle and constricted at either end at the internal and external uterine orifices.

Structure of the Uterus.—The uterus consists of three coats. The serous coat is formed by peritoneum. The muscular coat is bulky and is formed by unstriped muscle fibres. The mucous membrane lining the cavity of the body is smooth. In the cavity of the cervix the mucous membrane presents two longitudinal ridges, one on its anterior and the other on its posterior wall. From these longitudinal ridges oblique folds, called the *palmate folds*, pass upwards and lateralwards, presenting the appearance of a branching tree. This arrangement is known as the *arbor vitæ uterinæ*. Between the palmate folds, minute cysts containing fluid, called the *ovula Nabothi* are seen.

Structure of the Rectum and Anal Canal.—The coats are the same as in the male.

TABLE OF THE ARTERIES OF THE ABDOMEN

Abdominal Aorta gives off

1. Inferior phrenic .. Superior suprarenal
2. Cœliac artery ..
   - (a) Left gastric
     - Œsophageal
     - Cardiac
     - Gastric
   - (b) Hepatic ..
     - Right gastric
     - Gastroduodenal .. Right gastroepiploic; Superior pancreaticoduodenal
     - Right hepatic .. .. Cystic
     - Left hepatic
   - (c) Lienal
     - Pancreatic
     - Short gastric
     - Left gastro-epiploic
     - Terminal
3. Superior mesenteric..
   - (a) Inferior pancreatico-duodenal
   - (b) Jejunal and ileal
   - (c) Ileocolic .. ..
     - Superior
     - Inferior ..
       - colic
       - caecal
       - appendicular
       - ileal
   - (d) Right colic
   - (e) Middle colic
4. Middle suprarenal
5. Renal .. Inferior suprarenal
6. Testicular or ovarian
7. Inferior mesenteric..
   - Left colic
   - Sigmoid
   - Superior hæmorrhoidal
8. Lumbar
9. Middle sacral
10. Common iliac ..
    - External iliac ..
      - Inferior epigastric ..
        - External spermatic
        - Pubic
        - Muscular
        - Cutaneous
      - Deep circumflex iliac
    - Hypogastric
      - Anterior division .
        - Superior vesical .. Artery to the ductus deferens
        - Inferior vesical
        - Middle hæmorrhoidal
        - Uterine, Vaginal — In the female
        - Obturator ..
          - iliac
          - vesical
          - pubic
          - terminal .. anterior; posterior
        - Internal pudendal ..
          - Muscular
          - Inferior hæmorrhoidal
          - Perineal
          - Artery of the urethral bulb
          - Urethral
          - Deep artery of the penis
          - Dorsal artery of the penis
        - Inferior gluteal ..
          - muscular
          - vesical
          - coccygeal
          - arteria comitans nervi ischiadici
          - anastomotic
          - articular
          - cutaneous
      - Posterior division
        - Iliolumbar ..
          - iliac
          - lumbar
        - Lateral sacral
        - Superior gluteal ..
          - superficial
          - deep

TABLE OF THE VEINS OF THE ABDOMEN

Inferior Vena Cava receives

- 1. Common iliac receives ..
  - *a.* External iliac receives ..
    - Inferior epigastric
    - Deep iliac circumflex
    - Pubic
  - *b* *Hypogastric* receives ..
    - Superior gluteal
    - Inferior gluteal
    - Internal pudendal
    - Obturator
    - Lateral sacral
    - Middle hæmorrhoidal .. begins in hæmorrhoidal plexus
    - Vesical .. .. begins in vesical plexus
    - Uterine .. .. begins in uterine plexus
    - Vaginal .. begins in vaginal plexus
  - *c.* Iliolumbar
  - *d.* Middle sacral—into the left
- 2. Lumbar
- 3. Right testicular—Testicular of each side as also ovarian form pampiniform plexus or ovarian
- 4. Renal—Right; and Left renal which receives: Left inferior phrenic, Left suprarenal, Left testicular or ovarian
- 5. Right suprarenal
- 6. Right inferior phrenic
- 7. Hepatic

Portal Vein receives

- 1 Lienal receives .. ..
  - Short gastric
  - Left gastroepiploic
  - Pancreatic
  - Inferior mesenteric
- 2. Superior mesenteric receives .. ..
  - Jejunal
  - Ileal
  - Ileocolic
  - Right colic
  - Middle colic
  - Right gastroepiploic
  - Pancreaticoduodenal
- 3. Coronary
- 4. Right gastric
- 5. Cystic
- 6. Paraumbilical

TABLE OF THE NERVES OF THE ABDOMEN

VAGUS NERVE IN THE ABDOMEN

- Right vagus .. .. { gastric .. .. form..posterior gastric plexus; cœliac }
- Left vagus .. .. { gastric .. .. form..anterior gastric plexus; cœliac; hepatic }

SPINAL NERVES IN THE ABDOMEN

LUMBAR NERVES divide into

- A. Anterior divisions
  - (*a*) of these the first three and the greater part of the fourth form the *lumbar plexus* which gives off
    1. Iliohypogastric (from 1 L.) .. { Lateral cutaneous; Anterior cutaneous }
    2. Ilioinguinal (from 1 L.)
    3. Genitofemoral (from 1, 2 L.) { External spermatic; Lumboinguinal }
    4. Lateral femoral cutaneous (dorsal divisions 2, 3 L.) { Anterior; Posterior }
    5. Femoral (dorsal divisions 2,3,4 L.) { To iliacus; Other branches noted in the Table of the inferior extremity }
    6. Obturator (ventral divisions 2,3,4 L.)
    7. Accessory obturator (ventral divisions 3, 4 L.)

    (6 and 7) { Branches are noted in the Table of the inferior extremity }
  - (*b*) the remaining portion of the fourth unites with the fifth forming the lumbosacral trunk
- B. Posterior divisions . { Medial .. .. Muscular; Lateral .. .. { Muscular; Cutaneous (only upper three) } }

SACRAL NERVES and COCCYGEAL NERVE divide into

- A. Anterior divisions
  - (*a*) of these the first, portions of the 2nd and 3rd and the lumbosacral trunk form the *sacral plexus* which gives off
    1. Superior glutoal (4,5 L. 1 S.)
    2. Inferior gluteal (5, L. 1, 2 S.)
    3. Posterior femoral cutaneous 1,2,3 S.)
    4. Sciatic (4,5 L. 1,2,3 S.)
    5. To *quadratus femoris* and *gemellus inferior* (4,5 L. 1, S.)
    6. To obturator internus and gemellus superior (5 L. 1,2 S.)
    7. To piriformis (2 S.)
  - (*b*) the remaining portions of the second and third sacral nerves with the greater portion of the fourth form the *pudendal plexus* which gives off
    1. Pudendal (2,3,4 S.) { Inferior hæmorrhoidal; Perineal { Posterior scrotal or labial; Muscular }; Dorsal nerve of penis or clitoris }
    2. Perforating cutaneous (2,3 S.)
    3. Visceral (3,4 S.) .. To bladder, rectum, vagina
    4. Muscular (4 S.) { To levator ani, coccygeus, sphincter ani externus }
  - (*c*) the anterior division of the fifth sacral nerve and the coccygeal nerve, joined by a filament from the fourth sacral nerve form the *coccygeal plexus* which gives off
    - Anococcygeal nerves (4,5 S. and Coccyg.)
- B. Posterior divisions .. { Medial and lateral except lower two sacral and coccygeal }

SYMPATHETIC SYSTEM IN THE ABDOMEN

Sympathetic Trunk

- A. **Abdominal Portion** consists of ..
  - a. Four ganglia
    1. Give off grey rami communicantes to lumbar nerves
    2. Receives white rami communicantes from first three lumbar nerves
    3. Branches given to aortic plexus and hypogastric plexus
  - b. Intervening portions of the trunk
- B. **Pelvic Portion** .. consists of ..
  - a. Four or five ganglia ..
    1. branches given from first two ganglia to pelvic plexus
    2. Grey rami communicantes to sacral and coccygeal nerves
  - b. Ganglion impar or coccygeal ganglion .. where two trunks unite in front of coccyx—furnishes filaments to glomus coccygeum
  - c. Intervening trunks

Abdominal Plexuses of the Sympathetic

- A. **Cœliac Plexus** ..
  - a. Consists of .. Two cœliac ganglia connected by a network of nerve fibres
  - b. Receives .. Greater and lesser splanchnic nerves of both sides and filaments from right vagus
  - c. Furnishes the following secondary plexuses .. 1. Phrenic 2. Hepatic 3. Lienal 4. Superior gastric 5. Suprarenal 6. Renal 7. Spermatic or ovarian 8. Superior mesenteric 9. Abdominal aortic 10. Inferior mesenteric
- B. **Hypogastric Plexus** ..
  - Formed by filaments from lumbar ganglia and aortic plexus
  - Divides into two pelvic plexuses
- C. **Pelvic Plexuses** ..
  - a. Formed by prolongation of hypogastric plexus, by branches from 2nd, 3rd, and 4th sacral nerves, and by branches from first two sacral ganglia
  - b. Furnish the following secondary plexuses .. 1. Middle hæmorrhoidal 2. Vesical 3. Prostatic 4. Vaginal 5. Uterine

THE THORAX

The dissector of the thorax starts his work after the removal of the upper limbs; this is usually on the twelfth working day, that is to say, eleven days after the subject has been put on the table for dissection.

Before commencing with the actual dissection of the thorax, the student should study the parts constituting its framework from the hanging skeleton in the dissecting-room. The *framework of the thorax* is formed partly by bones and partly by cartilages and has a conical shape. Its *anterior wall* is formed by the sternum and the costal cartilages; its *posterior wall* is formed by the twelve thoracic vertebræ with the intervening fibrocartilages and the vertebral ends of the ribs as far as their angles. Its *lateral walls* are formed by the ribs, separated from each other by the intercostal spaces which are closed by the intercostal muscles in the recent state. Its *upper opening* or *inlet* is bound in front by the upper margin of the sternum on each side by the first rib and its cartilage and behind by the first thoracic vertebra. Its *lower opening* or *outlet* is bounded in front by the xiphoid process and the cartilages of the seventh, eighth, ninth, tenth and eleventh ribs; on each side by the twelfth rib and its cartilage and behind by the twelfth thoracic vertebra. The diaphragm closes the lower opening in the recent state forming the floor of the thorax.

THE THORACIC PARIETES

Dissection. Besides the bony and cartilaginous framework, the dissector has to study (1) the muscles, (2) the membranes, (3) the vessels, and (4) the nerves in the thoracic wall. The remains of the muscles attached to the thoracic wall viz., the pectoralis major and minor, the serrati posteriores, the rectus abdominis, the obliqui externus and internus abdominis, the latissimus dorsi and the subclavius are to be removed after noting the precise extent of their attachments. The cutaneous vessels and nerves near the midaxillary line and near the margin of the sternum are to be preserved. The intercostal muscles fill up the greater part of the intercostal spaces on each side of

the wall of the thorax and are arranged in each space in two layers, an external and an internal; the external layer constitutes the external intercostal and the internal layer, the internal intercostal muscle. Clean the external intercostal muscle in one of the intercostal spaces, say the third, and for this purpose the body will be required to be turned on to the side for a little while to exhibit the full extent of the muscle.

The **External Intercostal Muscles** (Fig. 46) are eleven in number on each side of the thorax. Each muscle arises from the lower border of the rib above and is inserted into the outer lip of the upper border of the rib below. The muscle fibres from their origin are directed downwards, forwards and medialwards. The first external intercostal muscle arises from the outer border of the first rib. Each external intercostal muscle extends from the tubercle to the junction of the rib with its cartilage. From the latter point to the margin of the sternum the muscle is prolonged as a membrane called the *anterior intercostal membrane.* In the upper two or three spaces the muscle fibres do not extend to the anterior ends of the ribs. In the tenth and eleventh intercostal spaces however the muscle fibres extend to the anterior ends of the intercostal spaces. Posteriorly each external intercostal muscle extends to the tubercle of the rib.

Dissection. Reflect the external intercostal muscle upwards in the third intercostal space by dividing it along the upper border of the fourth rib. Care should be taken that the intercostal vessels and nerves are not injured as they lie between the external and internal intercostal muscles. The internal intercostal muscle of the space is exposed.

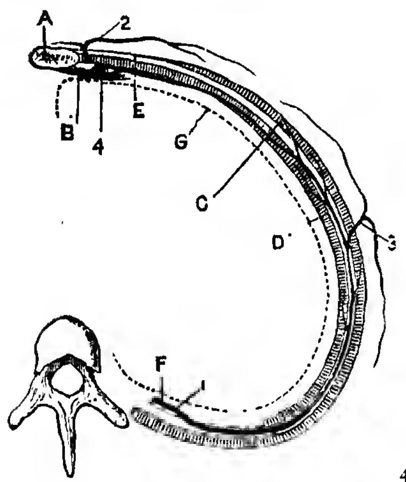
The **Internal Intercostal Muscles** (Fig. 46) are also eleven in number on each side of the thorax. Each muscle arises from the ridge which forms the upper boundary of the costal groove on the inner surface of a rib and also from the inner lip of the lower border of the corresponding costal cartilage. It is inserted into the inner lip of the upper border of the rib below and its cartilage. The first internal intercostal muscle arises from the lateral part of the under surface of the first costal arch. The muscle fibres are directed downwards and lateralwards in front of the thorax and downwards and backwards further posteriorly. Anteriorly each muscle extends to the end of the intercostal space but posteriorly it extends up to the angle of the rib beyond which it will be seen to be continued to the vertebral column by a membrane, called the *posterior intercostal membrane.*

Nerve-supply.—The intercostal muscles are supplied by the intercostal nerves. *Actions.*—The action of the intercostal muscles is not definitely known. Some hold that these intercostal muscles have no action on respiration except fixing the ribs during respiratory movements. But the probability is that the external intercostal muscles together with the interchondral portions of the internal intercostal muscles elevate the ribs and thus act as muscles of inspiration by increasing the antero-posterior and transverse diameters of the thorax. The interosseous portions of the internal intercostal muscles depress the ribs and hence act as muscles of expiration by diminishing the capacity of the thorax.

Dissection. The intercostal vessels and nerves should now be examined. The third intercostal space from which the external intercostal muscle has been reflected may be chosen and with the bone forceps the third rib is to be cut through in two places—first at its junction with its cartilage and next near the vertebral column by turning the body on its side. In dividing the rib care should be taken that the intercostal vessels and nerve contained in its costal groove are not injured. For this the lateral cutaneous branch of the third intercostal nerve should first be secured. This branch is the guide to the nerve and should be traced back till the parent trunk is found. The trunk of the nerve is to be pulled down with forceps and traced backwards along the costal groove. The intercostal artery and vein which lie above the nerve are to be pulled down and dislodged from the costal groove. The nerve is then to be traced towards the sternum till it ends as an anterior cutaneous nerve. The intercostal artery is easily dissected out if the colour injection has flown well into it. Having secured the nerve and blood vessels divide the internal intercostal muscle attached to the upper border of the costal groove. Divide also the intercostal muscles attached to the upper border of the third rib without injuring the pleura. Next detach the pleura from the inner surface of the rib with the handle of the scalpel. The portion of the third rib freed from the soft structures may now be easily removed with bone forceps.

The **Intercostal Nerves** (Fig. 46) are the anterior divisions of the thoracic nerves and are eleven in number on each side. They lie between the external and internal intercostal muscles on the lateral aspect of the thorax. About midway between the vertebral column and the sternum it runs through the substance

of the internal intercostal muscle as far as the junction of the rib with its cartilage and then passes between the pleura and the internal intercostal muscle. Further forwards it crosses in front of the internal mammary artery and the transversus thoracis and at the side of the sternum it perforates the internal intercostal muscle, the anterior intercostal membrane and the pectoralis major to become the *anterior cutaneous nerve* of the thorax. The lower six intercostal nerves on leaving the intercostal spaces enter the abdominal wall and their terminations as anterior cutaneous nerves near the linea alba have been described (p. 24).



A. Sternum.
B. Transversus thoracis
C. External intercostal muscle.
D. Internal intercostal muscle.
E. Anterior intercostal membrane.
F. Posterior intercostal membrane.
G. Costal pleura.

1. Intercostal nerve.
2. Anterior cutaneous nerve.
3 Lateral cutaneous branch.
4. Internal mammary artery.

Fig. 46.—Diagram to illustrate the external and internal intercostal muscles, the anterior and posterior intercostal membranes, and one of the upper intercostal nerves. (After Cunningham).

Branches of the intercostal nerves.—These are (1) muscular and (2) lateral cutaneous. The *muscular branches* of the upper five intercostal nerves supply the intercostal and subcostal muscles and the transversus thoracis. About midway between the vertebral column and sternum a *lateral cutaneous branch* is given off from each of the intercostal nerves except the first. It pierces the external intercostal muscle, passes between the digitations of the serratus anterior and divides into an anterior and a posterior branch, except the lateral cutaneous branch of the second.

The **Intercostal Arteries** (Fig. 65) are eleven in number and run from behind forwards in the intercostal spaces. Of these the upper two are the branches of the arteria intercostalis suprema which is a branch of the costocervical branch of the subclavian artery. The lower nine are derived from the thoracic aorta. They lie in the costal grooves between the external and internal intercostal muscles above the level of the intercostal nerves. Midway between the vertebral column and the sternum each intercostal artery gives off a *collateral branch* which descends to the upper border of the rib below. The main artery continues its course along the lower border of the rib above and its branch along upper border of the rib below. Both of these pass medialwards between the external and internal intercostal muscles towards the sternum to anastomose with the two anterior intercostal branches of the internal mammary artery in the upper six intercostal spaces and with those of the musculophrenic artery in the seventh, eighth and ninth spaces. The aortic intercostal arteries of the tenth and eleventh intercostal spaces pass medialwards into the anterior abdominal wall and have been described.

Branches.—Each intercostal artery gives off *muscular branches* to the muscles in the intercostal space and a *lateral cutaneous branch* which accompanies the lateral cutaneous nerve.

The *intercostal veins*, also known as the *posterior intercostal veins* for the purpose of distinguishing them from the anterior intercostal veins, accompany the arteries; each vein lies above the artery in the costal groove. Its termination will be seen at a later stage of the dissection.

The *anterior intercostal arteries* (Fig. 47) are the branches of the internal mammary artery in the upper six intercostal spaces and they arise from its musculophrenic branch in the succeeding three spaces. They are two in number in each intercostal space which pass lateralwards, one lying along the lower margin of the costal cartilage above and the other along the upper margin of the cartilage below, behind the internal intercostal muscle. Then they pierce this muscle and lie superficial to it and anastomose with the intercostal arteries which are proceeding towards the sternum. The anterior intercostal arteries are absent in the last two intercostal spaces. The *anterior intercostal veins* are tributaries of the musculophrenic and the internal mammary veins.

The student will note that in each intercostal space there are (*a*) one intercostal artery which runs from behind forwards

and later on divides into two branches and (*b*) two anterior intercostal arteries which proceed lateralwards from the front.

Dissection. Remove the intercostal muscles and membranes without injuring the parietal pleura which will be seen lining the inner aspect of the internal intercostal muscles and the costal arches. Care should also be taken of the musculophrenic branch and the anterior perforating branches of the internal mammary artery. The internal mammary artery with its companion veins will be seen lying about half an inch lateral to the sternum behind the costal cartilages and in front of the transversus thoracis. Note also the sternal lymph glands lying by the sides of these vessels.

The **Internal Mammary Artery** (Fig. 47) arises from the first portion of the subclavian artery in the neck. It enters the thorax behind the sternal end of the clavicle and the first costal cartilage. It then descends vertically about half an inch lateral to the sternum lying upon the pleura in the upper part of its course and upon the transversus thoracis in its lower part. Reaching the sixth intercostal it divides into two terminal branches, the musculophrenic and the superior epigastric arteries. It is covered in front by the upper six costal cartilages, the intervening internal intercostal muscles and anterior intercostal membranes and the terminal parts of the intercostal nerves. Two *venæ comitantes* accompany the artery and unite above to form a single trunk which terminates in the innominate vein of its own side.

Four or five glands, the *sternal* or *internal mammary lymph glands*, are seen along the course of each internal mammary artery. Their afferent vessels come from the upper part of the anterior abdominal wall, from the anterior wall of the thorax,and mamma. Their efferents unite to form a single trunk which opens into the subclavian trunk on the right side and into the thoracic duct on the left side. Sometimes they open at the junction of the internal jugular and subclavian veins.

The *branches* of the internal mammary artery are :—(1) The *pericardiaco-phrenic* (comes nervi phrenici) accompanies the phrenic nerve to the diaphragm and will be seen inside the thorax. (2) The *mediastinal branches* are minute twigs and supply the areolar tissue of the anterior mediastinum and the remains of the thymus gland. (3) The *pericardial branches* are minute twigs and supply the anterior surface of the pericardium. (4) The *sternal branches* supply the transversus thoracis and the back part of the sternum. (5) The *anterior intercostal arteries*

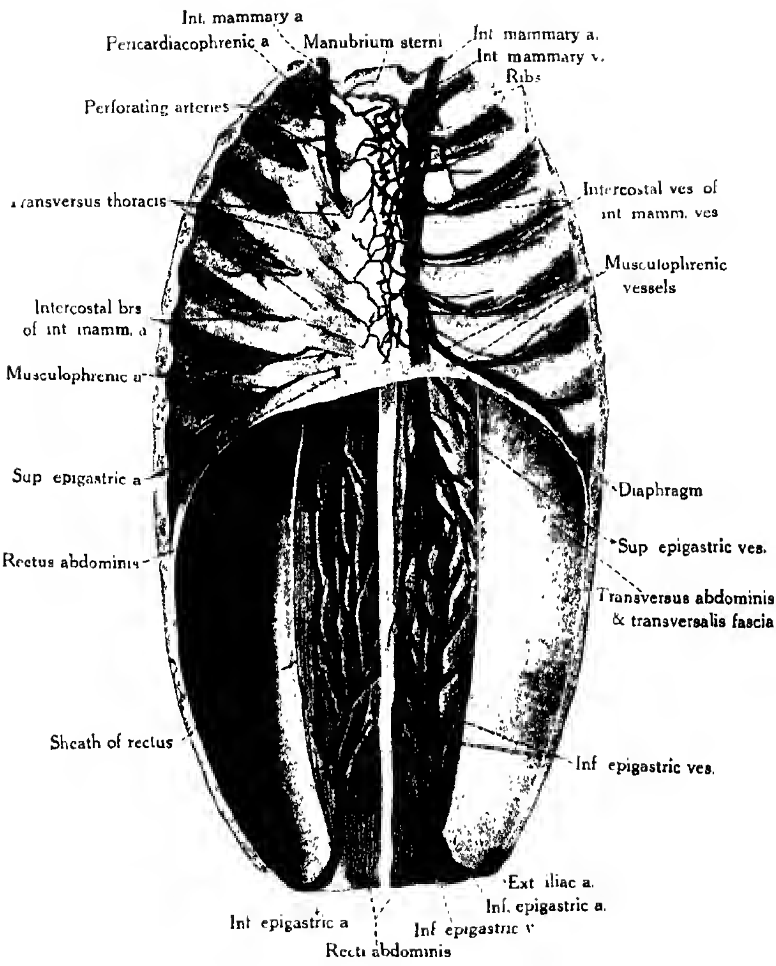


Fig. 47.—Posterior aspect of the anterior wall of the thorax and of the anterolateral wall of the abdomen (Sobotta).

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are two in number in each of the upper six intercostal spaces. They pass lateralwards and then anastomose with the branches of the arteria intercostalis suprema and the intercostal branches of the aorta. (6) The *perforating arteries* issue through the upper six intercostal spaces perforating the internal intercostal muscles, the anterior intercostal membranes and the pectoralis major and reach the integument of the thorax. In the female the perforating branches of the second, third and fourth spaces are of large size and supply the mammary gland. (7) The *musculophrenic* is the lateral terminal branch of the internal mammary artery. It runs downwards and lateralwards behind the costal cartilages and pierces the diaphragm opposite the eighth costal cartilage and terminates opposite the last intercostal space. It gives off (*a*) *muscular branches* to the diaphragm and (*b*) the *anterior intercostal branches* to the seventh, eighth and ninth intercostal spaces, which correspond to the anterior intercostal branches of the internal mammary artery. (8) The *superior epigastric artery* is the medial terminal branch of the internal mammary. It leaves the thorax by passing along the interval between the sternal and costal origins of the diaphragm. Its distribution inside the sheath of the rectus has been described (p. 32).

Transversus Thoracis (Triangularis sterni) (Fig. 47).—This muscle will be seen fully when the sternum with the costal cartilages is removed. It arises from (1) the posterior surfaces of the xiphoid process and the lower third of the body of the sternum and (2) the posterior surfaces of the fifth, sixth and seventh costal cartilages near the sternum. The upper fibres are oblique being directed upwards and lateralwards while the lower fibres are horizontal and continuous with the fibres of the transversus abdominis. It is inserted into the posterior surfaces and lower borders of the costal cartilages of the second, third, fourth, fifth and sixth ribs. It is supplied by the intercostal nerves. *Actions.*—It depresses the anterior parts of the ribs and thus helps expiration.

THE THORACIC CAVITY

The lungs and the heart are the chief viscera contained in the thoracic cavity. The two lungs occupy the sides of the cavity and each is covered by a serous membrane of its own called the pleura. Each lung is free within the thorax except at its root which consists of certain structures to be examined later on. The heart is situated between the lungs and is enclosed

in a membranous bag called the pericardium. The space lying between the two pleural sacs is called the mediastinum and is occupied by the pericardium and other structures which will be described later on.

Dissection. The student should now proceed to study the pleura. A certain amount of dissection is necessary to examine the reflections of this membrane. The sternum is to be sawn across (1) along the lower margins of the first pair of costal cartilages and (2) between the sixth and seventh pairs of costal cartilages. The second third, fourth, fifth and sixth costal cartilages are to be divided near their junction with the ribs. The anterior ends of the ribs from the second to the sixth are also to be divided by snipping them with bone pliers as far back as practicable. The pleura lining the internal intercostal muscles, the ribs and costal cartilages should be gently separated by the fingers. The intervening portion of the sternum with the costal cartilages attached to it should be removed after the attachments of the transversus thoracis and the pleura connected with this portion have been examined and should be preserved for the examination of the ligaments. A longitudinal incision is to be made down the whole length of the exposed pleura midway between the vertebral column and the sternum and transverse cuts are also to be made in the pleura so that the hand can be passed into the cavity of the pleural sac. The student can now see the visceral pleura adherent to the lung and trace with his fingers the lines of pleural reflection.

The **Pleura** (Fig. 48) is a delicate serous membrane which invests the lung and is then reflected over the structures contained in the mediastinum, over the inner surface of the wall of the thorax and over the diaphragm. The portion of the membrane investing the lung is called the pulmonary pleura. The remaining portion is called the parietal pleura. Between the pulmonary and parietal pleura is a potential space which is called the *cavity of the pleura*. It is only in diseased conditions that this potential space is seen between the two layers, otherwise they are in actual contact in the healthy subject; the space containing enough lymph to allow the lung to move freely in the thoracic cavity. Each pleura forms a completely closed sac, occupying its own half of the thorax and does not communicate with that on the opposite side. The two pleural sacs do not come into contact with each other except for a short distance behind the upper end of the body of the sternum.

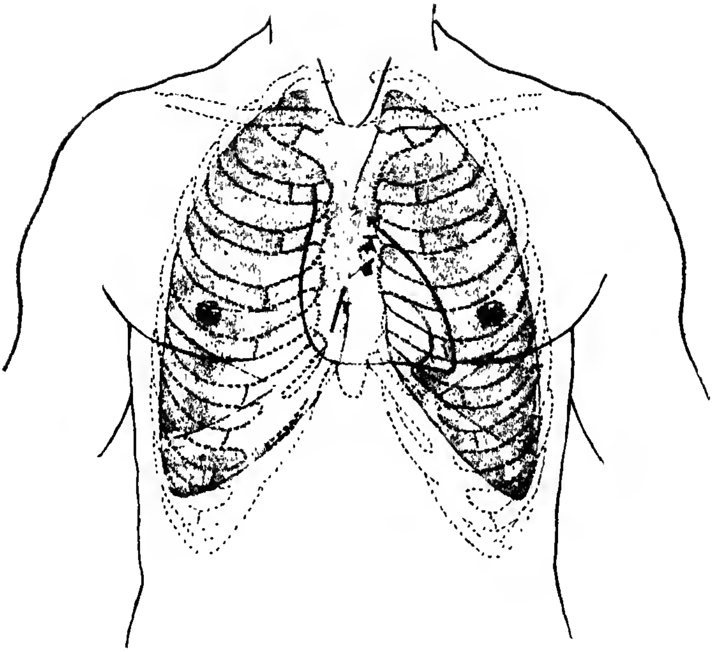

Fig 48.—The front of the thorax, showing the surface relations of the bones, lungs (purple), pleuræ (blue), and heart (red outline). (After Gray).

A.—Aortic valve. P.—Pulmonary valve.

B.—Bicuspid or mitral valve. T.—Tricuspid valve.

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Parietal Pleura.—The dissector should now trace the parietal pleura and define its limits. The parietal pleura is subdivided into four portions, viz., the costal pleura, the diaphragmatic pleura, the cervical pleura and the mediastinal pleura.

Costal Pleura.—Its anterior limit may be ascertained by introducing the fingers through the incision in the pleural cavity and pushing them towards the sternum. *Anteriorly* the pleural sacs extend from behind the sternoclavicular articulation to the midpoint of the angulus sterni. Thence the anterior limit of the right pleural sac descends vertically to the posterior surface of the xiphoid process. The left pleura descends vertically behind the sternum from the angulus sterni to the level of the fourth costal cartilage. Thence it diverges lateralwards and descends along the left margin of the sternum to the level of the sixth costal cartilage at its junction with the sternum. Traced *laterally* from the anterior limit behind the sternum the pleura lines the inner aspects of the ribs and their cartilages and the intercostal muscles till it reaches the heads of the ribs. From here it passes on to the sides of the bodies of the thoracic vertebræ. Thence it proceeds forwards forming part of the mediastinal pleura. Traced *above* it lines the inner margin of the first rib and is prolonged into the neck as the cervical pleura. Traced *below* it is reflected on the upper surface of the diaphragm forming the diaphragmatic pleura. The *lower limit* of the costal pleura where it is reflected on to the diaphragm differs on the two sides. The *right pleura* passes from behind the xiphoid process downwards and lateralwards behind the anterior extremity of the eighth rib and reaches the upper border of the tenth rib in the midaxillary line. Thence it passes backwards and medialwards across the eleventh rib and covering the head of the twelfth rib, it reaches the vertebral column at the level of the spine of the twelfth thoracic vertebra. The *left pleura* passes from the junction of the sternum with the left sixth costal cartilage downwards and lateralwards and lines the inner surface of the seventh costal cartilage. Then it proceeds across the inner surfaces of the eighth, ninth and tenth ribs reaching the lower border of the tenth rib in the midaxillary line. Thence it passes backwards and medialwards to the vertebral column covering the head of the twelfth rib; finally it descends a little lower down than the right pleura to a point midway between the head of the twelfth rib and the transverse process of the first lumbar vertebra.

The **Diaphragmatic Pleura** lines the upper surface of the

diaphragm and is continuous with the costal pleura at the line of its lower limit. It is continuous with the mediastinal pleura where the pericardium is attached to the diaphragm. The lower margin of the lung does not reach the line of junction of the costal and diaphragmatic pleura. Hence at that angle a space is left unoccupied by the lower margin of the lung. This space is called the *costophrenic sinus*.

The **Cervical Pleura** (cupola or dome of the pleura) is the continuation of the costal pleura above the level of the first rib. It projects into the neck for about one to two inches and is strengthened by an expansion of the deep fascia of the neck (*Sibson's fascia*), which is attached to the medial border of the first rib and transverse process of the seventh cervical vertebra.

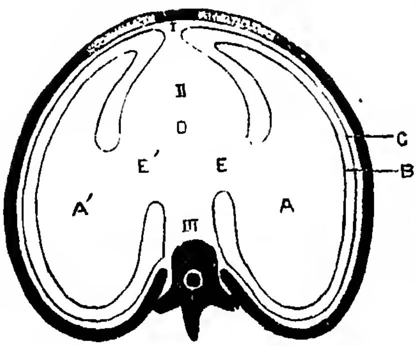
The **Mediastinal Pleura** is that portion of the parietal pleura which extends from the back of the sternum to the vertebral column. It forms the lateral boundary of the mediastinum and is divisible into two parts at the level of the root of the lung, an anterior part lying in front of the root of the lung and a posterior part lying behind it. The costal pleura from the back of the sternum is continued on the surface of the pericardium as the anterior part of the mediastinal pleura, and after covering the anterior surface of the root of the lung is continuous with the pulmonary pleura on the surface on the lung. The pulmonary pleura from the posterior surface of the root of the lung is continued backwards on the pericardium as the posterior part of the mediastinal pleura and thence further backwards on to the vertebral column to become continuous with the costal pleura. The *pulmonary ligament* (ligamentum latum pulmonis) is a triangular double fold of the mediastinal pleura extending from the side of the pericardium to the mediastinal surface of the lung. Its apex is attached to the lower border of the root of the lung and its base is free towards the diaphragm. Behind the sternum the anterior margins of the lungs do not extend up to the line of junction of the costal and mediastinal pleuræ. This angular space of the pleural sac unoccupied by the anterior margin of the lung is called the *costomediastinal sinus*.

The **Pulmonary Pleura** invests the surfaces of the lungs and dips between the fissures on them and is absent where the root of the lung enters. After covering the anterior and posterior surfaces of the roots of the lungs it becomes continuous with the mediastinal pleura.

The **Mediastinum** is the space between the two pleural sacs

containing all the viscera of the thorax except the lungs. The whole of this interpleural space is subdivided into four portions from the relations they bear to the pericardium (Fig. 49). The space marked I, situated between the sternum in front and the pericardium behind, represents the anterior mediastinum; the space II, which contains the pericardium is the middle mediastinum; and the space III, situated behind the pericardium, is the posterior mediastinum. In addition to these three spaces there is a fourth space not shown in the figure, as it lies on a higher plane being placed above the pericardium—this is the superior mediastinum.

The **Anterior Mediastinum** is that portion of the interpleural space which is bounded in front by the posterior surface of the sternum and behind by the pericardium. While tracing the sac of the pleura, the dissector has noticed that the two pleural sacs come into contact in the upper part of this mediastinal space.



A. Right lung.
A'. Left lung.
B. Pulmonary pleura.
C. Parietal pleura.
D. Pericardium.
E. Right pulmonary root.
E'. Left pulmonary root.
I. Anterior mediastinum.
II. Middle mediastinum.
III. Posterior mediastinum.

Fig. 49.—Diagram showing the two pleural sacs as seen in transverse section. The mediastinal spaces are also exhibited.

As a result of this there is practically no interpleural space in the upper part of the anterior mediastinum. The only space that can be demonstrated in the anterior mediastinum is on the left side and below the sternal extremities of the fourth pair of costal cartilages where the two pleural sacs separate from each other. The space contains some areolar tissue, two or three lymph glands, and the mediastinal branches of the internal mammary artery. The lymph glands receive the lymphatic vessels from the diaphragm and the upper surface of the liver and their efferents end chiefly in the broncho-mediastinal lymph trunk.

The **Middle Mediastinum** is the largest of the mediastinal spaces. It contains the pericardium enclosing the heart, the

ascending aorta, the lower portion of the superior vena cava with the termination of the azygos vein, the pulmonary arteries and veins, the phrenic nerves with the companion pericardiaco-phrenic arteries, the bifurcation of the trachea, and some bronchial lymph glands.

The **Posterior Mediastinum** is bounded in front by the pericardium ; behind by the vertebral column extending from the lower border of the fourth to the twelfth thoracic vertebræ ; laterally by the mediastinal pleura ; and below by the diaphragm. The contents of this space will be studied at a later stage of the dissection.

The **Superior Mediastinum** comprises that part of the interpleural space which lies above the upper level of the pericardium. It is bounded in front by the manubrium sterni, behind by the bodies of the upper four thoracic vertebræ, laterally by the mediastinal pleura, and below by an oblique plane extending from the lower border of the manubrium sterni to the lower border of the body of the fourth thoracic vertebra. The dissection of the structures at the root of the neck must have been sufficiently advanced by this time, so that the student has got an opportunity of examining most of the contents of this space. These are :—(1) The origins of the sterno-hyoid and sterno-thyreoid muscles as also the lower portions of the longus colli muscles ; (2) the transverse portion of the arch of the aorta with its three large branches, the innominate, the left common carotid, and the left subclavian arteries ; (3) the upper portion of the superior vena cava and the right and left innominate veins ; (4) the vagus, phrenic, cardiac and left recurrent nerves ; (5) the trachea, œsophagus, and thoracic duct ; and (6) the remains of the thymus gland and few lymph glands.

Dissection. The dissector should now examine the course of the phrenic nerve through the thorax. The mediastinal pleura is to be separated from the pericardium when the nerve will be exposed. The nerve should be traced from its entry into the thoracic cavity behind the subclavian vein above and followed along the side of the pericardium to its termination in the diaphragm.

The **Phrenic Nerve** (Fig. 53) arises in the neck by three roots from the third, fourth and fifth cervical nerves ; the root from the **fourth** being the largest. It descends on the scalenus anterior muscle, passes behind the subclavian vein and enters the superior mediastinum by crossing the internal mammary artery near the

origin of the vessel. It then runs downwards in the middle mediastinum, lying by the side of the pericardium and in front of the ~~root of the lung. It then reaches the upper surface of the diaphragm~~ where it breaks up into branches which pierce the muscle and are distributed on its inferior surface.

It should be noticed that the phrenic nerves of the two sides differ from each other in their course, relations and length. The *right phrenic nerve* is placed more deeply, is more vertical in its course and lies lateral to the right innominate vein and superior vena cava. The *left phrenic nerve* lies between the left common carotid and the left subclavian arteries behind the left innominate vein and crosses the left side of the arch of the aorta. It is longer than the right phrenic nerve, due to its curving over the apex of the heart which projects to the left and also due to the diaphragm being on a lower level on the left side than on the right.

Besides supplying branches chiefly to the diaphragm, the phrenic nerve also gives fine filaments to the pericardium and pleura during its course through the thorax. The pericardiaco-phrenic branch of the internal mammary artery accompanies the phrenic nerve in the thorax.

The **Lungs** (Figs. 50, 51, 52) are placed, each in its own half of the thoracic cavity separated from each other by the pericardium containing the heart. There is a good deal of difference between a healthy lung in a living subject and the lung that is commonly seen in the dissecting-room. The dissector usually finds that the lung is very much collapsed (unless previously hardened by formalin) and hence does not accurately fit into the cavity containing it. Frequently the lung does not remain free in the thoracic cavity owing to old inflammatory adhesions between the pulmonary and parietal pleuræ. Moreover the lung does not bear any indentations of the structures with which it is in contact unless it is hardened in situ. A healthy lung is of a mottled slate colour and of spongy texture; it floats in water and crepitates when handled with the fingers. The right lung weighs about 22 ounces and the left 20 ounces; the variation in weight depends upon the amount of blood contained in it. Each lung is conical in form and presents for examination an apex, a base, two surfaces, and three borders.

Apex.—The apex is rounded and projects into the root of the neck for about one inch to one inch and a half above the level

of the first rib. On its anterior aspect an indentation for the subclavian artery is seen.

Base.—The base is concave and rests on the upper surface of the diaphragm. In as much as the diaphragm rises higher on the right side than on the left, the base of the right lung is more deeply concave than that of the left. The relations of the bases of the lungs with some of the abdominal viscera are important, being separated from them by the diaphragm alone. Thus, the base of the right lung is in relation with the right lobe of the liver, and the base of the left lung with the left lobe of the liver, the stomach and the spleen.

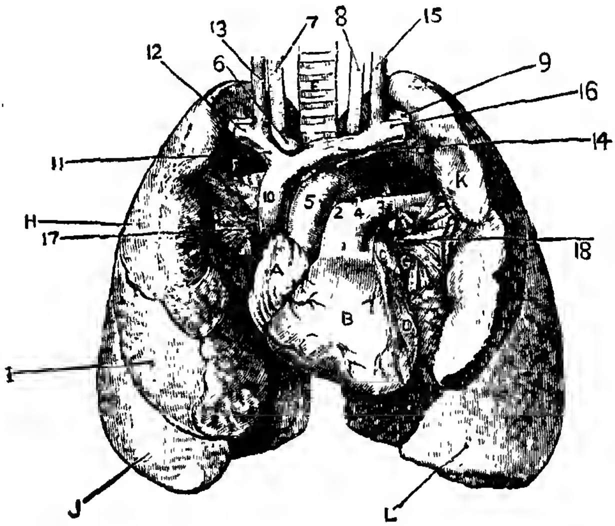


Fig. 50.—The heart and lungs. Anterior aspect.

A. Right atrium.
B. Right ventricle.
C. Left auricula.
D. Left ventricle.
E. Trachea.
F. Right bronchus.
G. Left bronchus.
H. Upper lobe of right lung.
I. Middle lobe.
J. Lower lobe
K. Upper lobe of left lung.
L. Lower lobe.
1. Pulmonary artery.
2. Right pulmonary artery.
3. Left pulmonary artery.
4. Ligamentum arteriosum.
5. Arch of the aorta.
6. Innominate artery.
7. Right common carotid artery.
8. Left common carotid artery.
9. Left subclavian artery.
10. Superior vena cava.
11. Right innominate vein.
12. Right subclavian vein.
13. Right internal jugular vein.
14. Left innominate vein.
15 Left internal jugular vein.
16. Left subclavian vein.
17. }
18. } Pulmonary veins.

Surface.—The *costal surface* is convex and lies in contact with the costal pleura ; it is adapted to the cavity of the thorax

The *medial surface* may be divided into (1) an anterior or mediastinal part which lies in contact with the mediastinal pleura, and (2) a posterior or vertebral part which rests upon the sides of the bodies of the vertebræ. It presents a deep concavity, the *pericardial concavity*, which accomodates the pericardium containing the heart. The concavity in the medial surface of the left lung is more marked than on the right due to the greater projection of the heart on the left side. A little above and behind the middle of this surface is a triangular depressed area, the *hilum pulmonis*, through which the structures forming the root of the lung pass. These structures are enclosed by pleura which is continuous below with the pulmonary ligament.

Impressions.—If the lungs are hardened in situ certain impressions are seen on their medial surfaces produced by the structures against which they lie. Thus in the *right lung* (1) a narrow arched groove above the hilum ~~produced by the~~ azygos vein is seen. (2, 3) Two vertical grooves run upwards above the former to a little below the apex of the lung ; one of them lies in front and the other behind. The lower part of the anterior groove lies against the superior vena cava and the upper part of it against the right innominate vein. The posterior groove is produced by the innominate artery. (4) A third vertical groove is situated behind the hilum and the pulmonary ligament and is produced by the œsophagus. (5) A short groove for the inferior vena cava is situated in front and to the right of the œsophageal groove. On the medial surface of the *left lung* are seen (1) a broad arched groove above the hilum caused by the arch of the aorta ; (2, 3) two vertical grooves above the former, one of them lying in front and the other behind. The groove in front is caused by the left innominate vein and the groove behind is for the left subclavian artery. (4) A third vertical groove lies behind the hilum and the pulmonary ligament for the descending aorta.

Borders.—The *anterior border* is very thin and sharp ; it projects towards the costomediastinal sinus and overlies the pericardium. The anterior border of the left lung presents in its lower part a notch, the *cardiac notch*, where the pericardium is exposed. The *posterior border* is thick and rounded and fits into the concavity on either side of the vertebral column. The *inferior border* or circumference of the base of the lung is thin at the line of separation of the costal surface from the base and projects into the costophrenic sinus ;

medially it is rounded where it separates the base from the medial surface.

Fissures and Lobes of the Lungs.—Each lung is divided into an *upper* and a *lower lobe* by a long and deep *oblique fissure* which penetrates nearly to the hilum. This fissure begins at the upper and back part of the hilum and passes upwards and backwards to the posterior border of the lung a little below the apex. Then it crosses the costal surface by passing downwards and forwards and cuts the inferior border of the lung a little behind the anterior border. Thence it passes to the lower part of the hilum along the medial surface of the lung. The upper lobe of the right lung is further subdivided by a *transverse fissure* which begins at the posterior border of the lung where it is cut by the oblique fissure and runs horizontally forwards to the anterior border of the organ at the level of the fourth costal cartilage ; it then runs backwards on the medial surface to the hilum. This fissure cuts off from the lower part of the upper lobe a wedge-shaped portion called the *middle lobe.*

The following points of difference between the right and the left lung should be noted. (1) The right lung is shorter owing to its base being pushed upwards by the right lobe of the liver. (2) The right lung is wider than the left lung owing to the heart projecting more to the left side. (3) The anterior border of the right lung is straight while that of the left lung presents a notch, the cardiac notch. (4) The pericardial concavity on the medial surface of the left lung is deeper than that on the right lung. (5) The base of the right lung is more deeply concave than that of the left. (6) There are three lobes and two fissures in the right lung but two lobes and one fissure in the left. (7) The relations of the structures forming the root of the lung differ on the two sides. (8) Differences are presented on the two lungs caused by the impressions on their medial surfaces.

Root of the Lung.—This term is employed to denote a collection of structures which enter and leave the hilum of the lung. On both sides the phrenic nerve lies in front of the root and the vagus nerve behind it. The root of the right lung is placed behind the superior vena cava and below the azygos vein, while that of the left lung lies in front of the descending aorta and below the arch of the aorta.

The dissector should now examine the *constituent parts of the root of the lung.* These are the bronchial tube, the pulmonary artery, the two pulmonary veins, one or two small bron-

chial arteries and veins, the pulmonary nerves, lymphatic vessels, bronchial lymph glands, and areolar tissue all of which are enclosed by pleura.

Dissection. Remove the pleura covering the root of the lung taking care of the nerve filaments which form the anterior and posterior pulmonary plexuses. The anterior pulmonary plexus will be seen in front of the root, while to display the posterior pulmonary plexus, the lung should be thrown forwards and held with chain-hooks. The bronchial artery is to be searched for behind the bronchial tube. The bronchus, the pulmonary artery and the pulmonary veins are to be separated from each other.

Pulmonary Plexuses of Nerves.—The *anterior pulmonary plexus* is formed in front of the root of the lung by two or three anterior bronchial branches derived from the vagus, which join with filaments from the sympathetic. It also receives twigs from the cardiac plexus. The *posterior pulmonary plexus* is found behind the root of the lung and is formed by a large number of posterior bronchial branches derived from the vagus which join with filaments from the third and fourth sympathetic ganglia. From this plexus branches are distributed to the bronchial tubes and bronchial blood vessels.

The **Bronchial Arteries** are the nutrient vessels of the lungs. As a rule there are two left bronchial arteries and one right bronchial artery. The *right bronchial artery* arises either from the first aortic intercostal artery or conjointly with the upper left bronchial artery from the front of the descending aorta. The *left bronchial arteries* arise from the descending aorta. Each vessel runs behind the corresponding bronchus and accompanies it to be distributed to the bronchial tubes, the cellular tissue of the lung and the bronchial lymph glands. The *bronchial veins* formed by minute twigs corresponding to the branches of the bronchial arteries open on the right side into the azygos vein and on the left side into the left superior intercostal vein or into the accessory hemiazygos vein.

The other structures of the root of the lung will be described later on.

The disposition of the structures constituting the root of the lung from before backwards is the same on both sides, viz., the pulmonary veins anteriorly, the pulmonary artery in the middle and the bronchus posteriorly. From above downwards the arrangement differs on the two sides. On the right side are

seen—1st, the bronchus (eparterial), 2nd, the pulmonary artery, 3rd, the bronchus (hyparterial). 4th, the pulmonary veins ; while on the left side—1st, the pulmonary artery, 2nd, the bronchus, 3rd, the pulmonary veins. This difference is due to the bronchus of the right side giving off a branch to the upper lobe of the lung before the pulmonary artery passes over it. The bronchus of the left side does not give off a corresponding branch and the pulmonary artery passes over the undivided bronchus.

Surface markings of the Lungs and Pleuræ.—For convenience of surface markings of the pleura and lungs, certain lines are drawn on the surface of the thorax. These lines are (1) the *midsternal* or median ; (2) the *mammary* which passes vertically down wards from the middle of a line drawn from the centre of the jugular notch to the tip of the acromion ; (3) the *lateral sternal* along the margin of the sternum ; (4) the *parasternal*, drawn from the midpoint of the lateral sternal and mammary lines ; (5, 6) the *anterior* and *posterior axillary* drawn from the anterior and posterior axillary folds respectively ; (7) the *midaxillary*, drawn from the apex of the axilla ; (8) the *scapular*, drawn vertically from the inferior angle of the scapula. The *lower border of the lung* is indicated by a line drawn from the sixth sterno-costal joint with a slight convexity downwards to the tenth thoracic spinous process. This line crosses the parasternal line at the sixth rib, the midaxillary line at the eighth rib, and the scapular line at the tenth rib. The line of the lower border of the pleura is one rib below : thus it crosses the parasternal, midaxillary and scapular lines at the seventh, ninth and eleventh ribs respectively. The *oblique fissure* is marked by a line drawn downwards and forwards round the thorax from the spinous process of the second thoracic vertebra to the sixth costal cartilage. The *horizontal fissure* of the right lung is marked by a line drawn lateralwards from the fourth costal cartilage till it meets the line of the oblique fissure.

Dissection. The pericardium should now be studied and the great vessels of the heart viz., the superior and inferior venæ cavæ, right and left pulmonary arteries, pulmonary veins and the aorta are to be recognised. The superficial cardiac plexus lying in the concavity of the arch of the aorta should then be dissected out.

The **Pericardium** (Fig. 53) is a conical fibroserous bag containing the heart and the roots of the great vessels. *In front* of it is the anterior mediastinum. It is partly covered in front by the

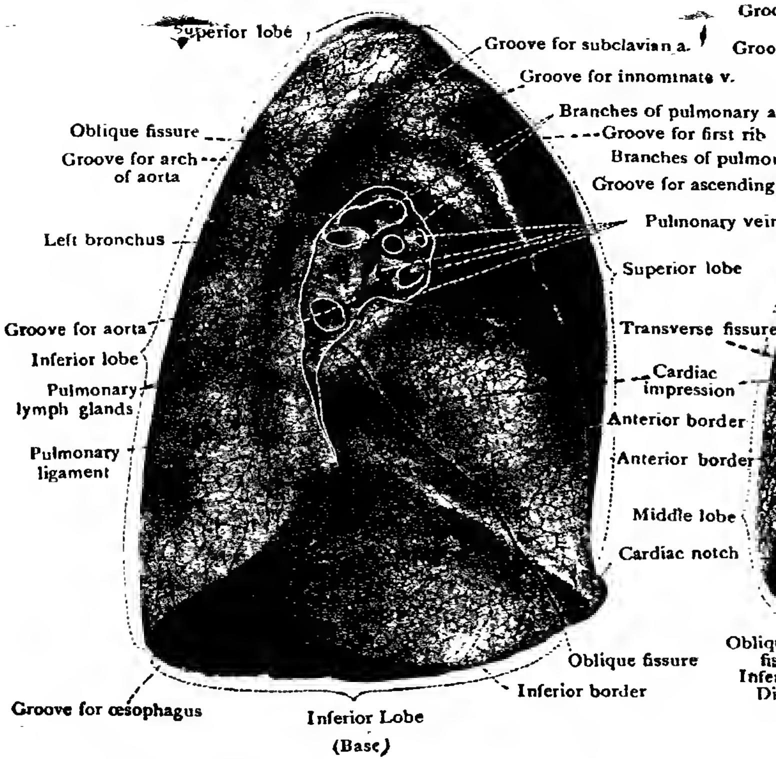


Fig. 51.—The mediastinal surface of the left lung (Sobotta).

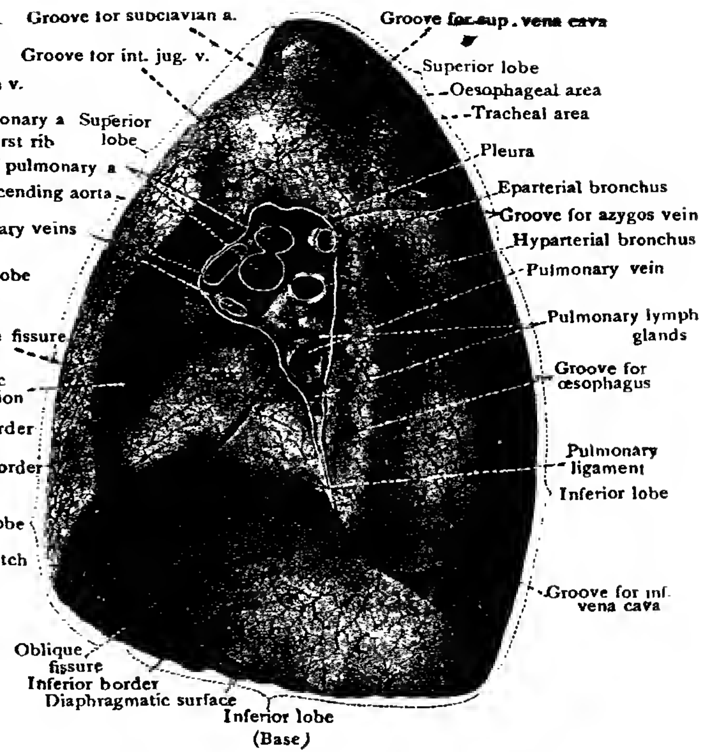


Fig. 52.—The mediastinal surface of the right lung (Sobotta).

XV

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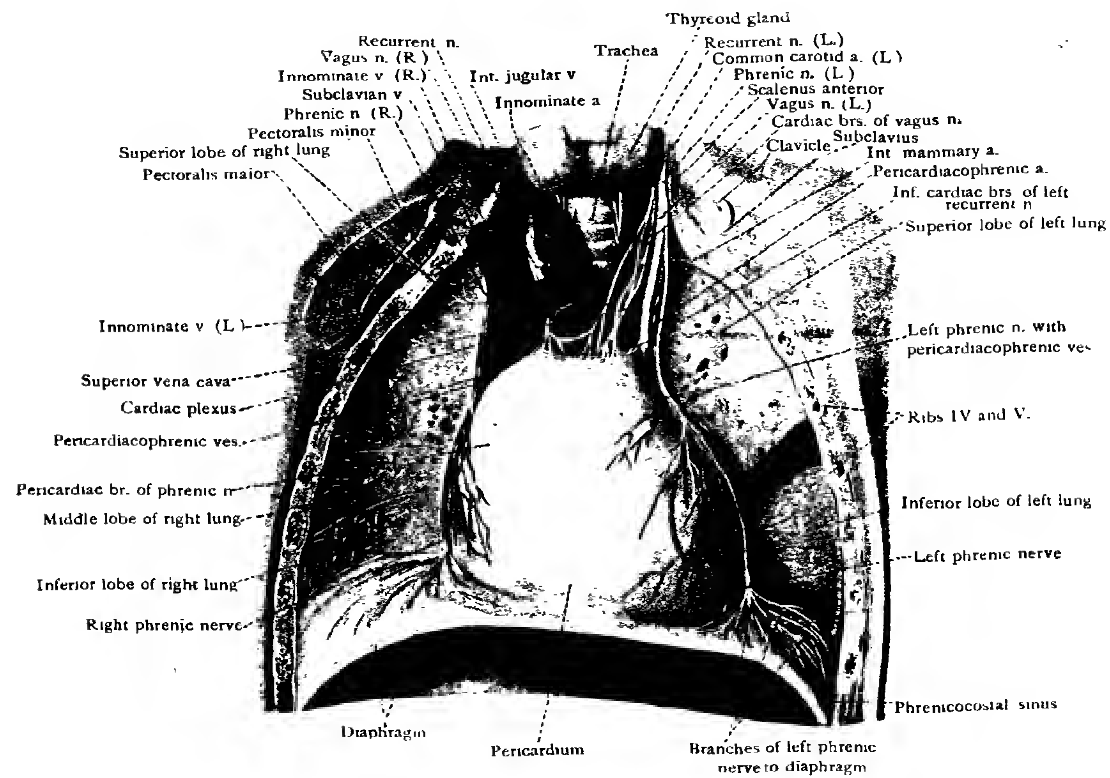

Fig. 53.—The pericardium and great vessels of the heart. The course of the phrenic nerve is also shown (Sobotta).

anterior margins of the lungs and the pleuræ. *Behind* it, is the posterior mediastinum with its contents. *Laterally* it lies in contact with the mediastinal pleuræ, and the phrenic nerve with the pericardiaco-phrenic artery runs down between the pericardium and pleura on either side. Its *base* is attached mainly to the central tendon of the diaphragm. Its *apex* is prolonged over the great vessels connected with the base of the heart.

Structure.—The pericardium consists of two layers, an external fibrous and an internal serous layer. The *fibrous layer* is attached below to the central tendon of the diaphragm encroaching upon its left muscular part. *Above* it is prolonged on the great vessels forming tubular sheaths for them (except for the inferior vena cava) and is continued with the pretracheal layer of the fascia colli. In front it is attached to the sternum by two fibrous bands called the *superior* and *inferior sternopericardial ligaments*. The superior one passes to the back part of the manubrium and the inferior one to the back part of the xiphoid process. The *serous layer* forms a shut sac. To expose it the pericardium is to be opened by two incisions, a longitudinal from the aorta to the diaphragm and a transverse from one root of the lung to the other. The serous layer is divisible into two portions, a parietal and a visceral. The *parietal portion* lines the inner surface of the fibrous layer and is reflected over the heart to form the visceral portion or *epicardium*. The great vessels connected with the heart receive coverings from the visceral portion to the extent of about an inch and a half. The ascending aorta and the pulmonary artery are enclosed in a single complete sheath of the visceral layer called the *arterial mesocardium*, while the two venæ cavæ and the four pulmonary veins are enclosed in a separate sheath of the visceral layer called the *venous mesocardium* which is arranged in the form of an inverted U. The finger can be easily passed into the space behind the arterial mesocardium. This space is called the *transverse sinus of the pericardium*. If the apex of the heart is raised the finger can be passed from below into the pouch of the venous mesocardium between the two limbs of the inverted U. This pouch is called the *oblique sinus of the pericardium.*

Between the left pulmonary artery and the left upper pulmonary vein a triangular fold of the serous layer exists. This is known as the *ligament of the left vena cava* (Vestigeal fold of Marshall). It contains the fibrous remains of the lower part of the left superior vena cava of the embryo.

The **Superficial Cardiac Plexus** (Fig. 53) is situated in the concavity of the arch of the aorta and above the bifurcation of the pulmonary artery. It is formed by (1) the superior cardiac branch of the left sympathetic trunk and (2) the lower of the superior cardiac branches of the left vagus nerve which arises at the root of the neck. Trace these two cardiac nerves as they cross the left part of the aortic arch to reach its concavity. A small ganglion, the *ganglion of Wrisburg*, is usually found at the point of junction of these nerves. Filaments from the deep cardiac plexus lying behind the arch of the aorta also join the superficial cardiac plexus. The superficial cardiac plexus distrubutes branches to the anterior coronary and left anterior pulmonary plexuses.

Directions. The study of the heart should now engage the attention of the dissector. The organ should not be removed from the thoracic cavity but all examinations of its exterior and interior should be made *in situ*.

The **Heart** is a hollow muscular organ which receives and propels blood.

I. **Position**.—The heart lies obliquely in the middle mediastinum between the two lungs inside the pericardium. It projects more into the left side than into the right, about one third of the organ lying to the right, and about two thirds of it to the left of the mesial plane.

II. **Shape and Size**.—The heart has the shape of an irregular cone. A normal heart measures five inches in length, three and a half inches in breadth, and two and a half inches (6·25 cm.) in thickness.

III. **Component Parts**.—There are grooves on the outer surface of the heart which indicate the internal subdivision of the organ into four cavities. Thus a transverse groove, called the *coronary sulcus* (auriculoventricular groove) runs transversely showing the line of separation of the upper two chambers called the atria from the lower two chambers called the ventricles. The groove is deficient in front being crossed by the root of the pulmonary artery. Another groove, the *interatrial groove* (interauricular groove), which runs vertically upwards from the preceding groove on the posterior aspect of the atrial portion of the heart, shows the line of separation between the right and left atria. A vertical groove, called the *anterior longitudinal sulcus* (anterior interventricular groove), passes over the sternocostal surface of the ventricular portion of the

heart near its left border. It ends below at the inferior border of the heart close to the apex, where a notch is seen immediately to the right of the apex, called the *incisura apicis cordis*. This sulcus shows the line of subdivision of the ventricular portion into a right and a left ventricle anteriorly. Another vertical groove, called the *posterior longitudinal sulcus* (posterior interventricular groove), extends from the coronary sulcus to the incisura apicis cordis on the diaphragmatic surface of the ventricles close to the right border of the heart. This sulcus indicates the line of separation between the right and left ventricles posteriorly.

IV. **General Description.**—The heart presents for examination a base, an apex, two surfaces, and three borders. The *base* is the attached end of the organ and is formed chiefly by the left atrium and by a small portion of the right atrium. It is directed upwards, backwards and to the right and is placed opposite the fifth to eighth thoracic vertebræ inclusive. The *apex* is somewhat rounded and is formed entirely by the left ventricle. It is directed downwards, forwards and to the left and lies against the left fifth intercostal space three and a half inches (9 cm.) to the left of the midsternal line. The *sterno-costal surface* is convex and is formed chiefly by the right atrium and the right ventricle and to a small extent by the left atrium and left ventricle. On it are seen the coronary sulcus and the anterior longitudinal sulcus. This surface is placed behind the body of the sternum and the cartilages of the third to sixth ribs inclusive. The *diaphragmatic surface* is flattened and is formed chiefly by the left ventricle and to a small extent by the right ventricle. It lies mostly on the central tendon and on a small portion of the left muscular part of the diaphragm and on it are seen the posterior part of the coronary sulcus and the posterior longitudinal sulcus. The right border is almost vertical and placed behind the third, fourth and fifth costal cartilages. It is rounded and formed by the right atrium. The *left border* is thick and rounded and formed chiefly by the left ventricle and to a small extent by the left auricula. The *inferior border* is almost horizontal and extends from the apex of the heart to the sternal end of the sixth right costal cartilage. It is thin and formed by the right ventricle.

V. **Arteries.**—The coronary arteries supply the heart with blood for its nutrition, and are two in number, a right and a left.

Dissection. The two coronary arteries (right and left)

are to be dissected on the surface of the heart. For this the visceral pericardium and the fat surrounding the vessels should be removed and the two arteries should be traced from their origin from the aorta to their terminations. A plexus of nerves is seen with each artery and the plexus on the right artery is to be followed to the superficial cardiac plexus.

The **right coronary artery** arises from the anterior aortic sinus. It passes forwards between the root of the pulmonary artery and the right auricula. It then turns to the right along the coronary sulcus, winds round the right margin of the heart and passes towards the left along the coronary sulcus on the diaphragmatic surface of the heart. Reaching the upper end of the posterior longitudinal sulcus it divides into a small transverse branch and a posterior descending branch. The *transverse branch* continues the course of the main artery along the coronary sulcus and anastomoses with the circumflex branch of the left coronary artery. The *posterior descending branch* descends along the posterior longitudinal sulcus towards the apex of the heart. While at the right margin of the heart the right coronary artery gives off a *marginal branch* which runs along the inferior border of the heart towards the apex and supplies branches to both surfaces of the right ventricle. The **left coronary artery** is larger than the right and arises from the left posterior aortic sinus. It passes to the left behind the pulmonary artery and then between the pulmonary artery and the left auricula and divides into two branches. One of these, the *circumflex branch*, runs to the left along the coronary sulcus, curves round the left margin of the heart to the diaphragmatic surface of the organ and anastomoses with the transverse branch of the right coronary artery; while the other, the *anterior descending branch*, runs downwards along the anterior longitudinal sulcus to the apex of the heart anastomosing with the posterior descending branch of the right coronary artery.

VI. **Veins**.—The veins which return the blood from the substance of the heart are :—(1) The *coronary sinus* which is a dilated venous channel situated in the coronary sulcus on the diaphragmatic surface of the heart between the left atrium and the left ventricle. It is about an inch (2.5 cm.) in length and opens by its right end into the right atrium of the heart. (2) The *great cardiac vein* begins at the apex of the heart. It ascends along the anterior longitudinal sulcus and turns to the left in the coronary sulcus. It then curves round the left margin

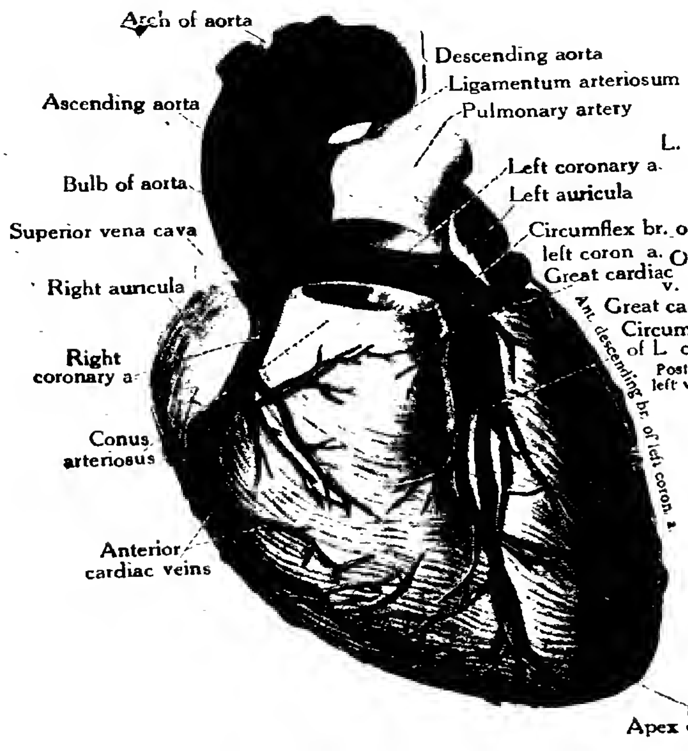

Fig. 54.—The sternocostal surface of the heart (Sobotta).

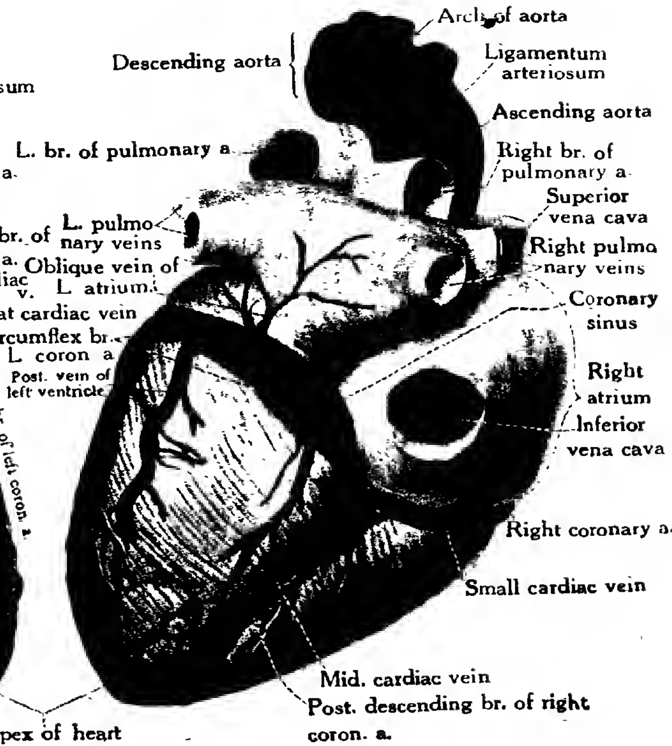

Fig. 55.—The diaphragmatic surface of the heart (Sobotta).

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of the heart to open into the left end of the coronary sinus. In its course it receives several small veins including the *left marginal vein* which ascends along the left margin of the heart. (3) The *posterior cardiac vein* runs upwards along the diaphragmatic surface of the left ventricle and opens into the coronary sinus. (4) The *middle cardiac vein* ascends along the posterior longitudinal sulcus and opens into the coronary sinus. (5) The *anterior cardiac veins* are usually three or four in number and run along the sternocostal surface of the right ventricle. They open directly into the lower part of the atrium. (6) The *small cardiac vein* (right coronary vein) lies in the coronary sulcus between the right atrium and ventricle, curves round the right margin of the heart and opens into the right extremity of the coronary sinus. It receives the *right marginal vein* which runs along the inferior border of the heart. (7) The *oblique vein of the left atrium* (oblique vein of Marshall) begins at the ligament of the left vena cava and terminates in the left extremity of the coronary sinus by passing obliquely along the posterior aspect of the left atrium. (8) The *venæ cordis minimæ or smallest cardiac veins* (venæ Thebesii) are minute veins which transmit the blood from the muscular substance of the heart directly into the right atrium. They are not seen on the surface of the heart and their openings into the right atrium will be seen when that chamber is opened. If the coronary sinus is slit open the openings of its tributaries will be seen to be provided with valves with the exception of the oblique vein of the atrium.

VII. **Nerves.**—The nerve supply of the heart is derived from the coronary plexuses which are two in number, a right (anterior) and a left (posterior). The *right coronary plexus* accompanies the right coronary artery and is derived from the superficial cardiac plexus and also from the deep cardiac plexus. The *left coronary plexus* accompanies the left coronary artery and is derived from the deep cardiac plexus only. Minute ganglia are found in these plexuses. Filaments from these plexuses terminate in the muscle fibres of the heart.

VIII. **Chambers of the Heart.**—The heart consists of four chambers, viz., right and left atria, and right and left ventricles.

Dissection. Open the right atrium by an incision from the point of entrance of the superior vena cava to that of the inferior vena cava along the right margin of the atrium. From the upper end of this incision carry the knife to the tip of the auricula.

Reflect the flaps and fix them with hooks. The dissector should wash away all blood and clot from the cavity. (Fig. 56).

The **Right Atrium** (Right auricle) consists of two parts, the sinus venarum and the auricula. The sinus venarum is the main chamber and is situated between the superior and inferior venæ cavæ. The auricula (Auricular appendix) is the ear-shaped projection which is directed forwards and to the left overlapping the root of the aorta. A groove, seen on the outer surface of the atrium and called the *sulcus terminalis*, extends from the front of the superior vena cava to the front of the inferior vena cava and indicates externally the line of separation between the sinus venarum and the auricula. In the interior of the atrium this separation is indicated by a vertical ridge called the crista terminalis which corresponds in position to the sulcus terminalis.

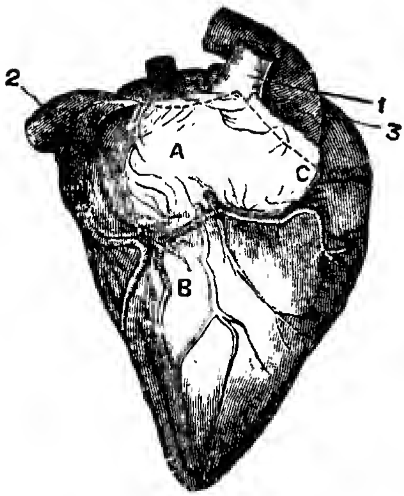


Fig. 56.—Diagram showing how the right atrium should be opened. The dotted lines indicate the direction of the incisions.

A. Right atrium.
B. Right ventricle.
C. Right auricula.
1. Superior vena cava.
2. Inferior vena cava.
3. Aorta.

In the interior of the right atrium the following parts are to be examined:—The orifices of (1) the superior vena cava, (2) the inferior vena cava, (3) the coronary sinus, and (4) the anterior and smallest cardiac veins; (5) the right atrioventricular orifice, (6) the valve of the inferior vena cava, (7) the valve of the coronary sinus, (8) the fossa ovalis, (9) the limbus fossa ovalis, (10) the musculi pectinati and the crista terminalis, and (11) the intervenous tubercle.

The *orifice of the superior vena cava* is situated at the upper and back part of the right atrium and is directed towards the right atrioventricular opening. It is not guarded by any valve. The

orifice of the inferior vena cava is placed at the lower part of the right atrium and is directed towards the atrial septum. It is guarded by a valve. The *orifice of the coronary sinus* is situated between the opening of the inferior vena cava and the right atrioventricular opening. It is guarded by a valve. The *orifices of the anterior cardiac veins* and *of the smallest cardiac veins* (Venæ cordis minimæ) are minute openings scattered over the internal surface of the atrium. The *right atrioventricular orifice* is the opening by which the right atrium communicates with the right ventricle. It admits the tips of three fingers and is guarded by a valve.

The *valve of the inferior vena cava* (Eustachian valve) is semilunar in shape; it is formed by a duplicature of the lining membrane of the heart, called the endocardium, and contains a little muscular tissue. Its convex margin is attached to the

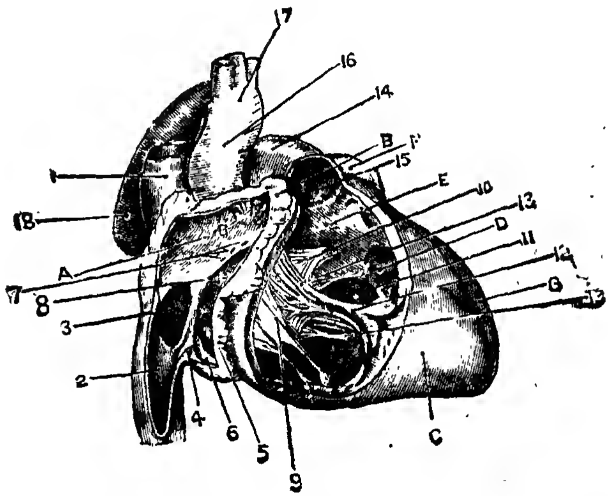


Fig. 57.—The interior of the right atrium and right ventricle.

A. Cavity of right atrium.
B. Auricula.
B'. Musculi pectinati.
C. Right ventricle.
D. Cavity of right ventricle.
E. Conus arteriosus.
F. Apex of left auricula.
G. Left ventricle.
1. Superior vena cava.
2. Inferior vena cava.
3. Fossa ovalis.
4. Valve of the inferior vena cava.
5. Opening of the coronary sinus.
6. Coronary valve.
7. Orifices of venæ cordis minimæ.
8. Commencement of auriculo-ventricular opening.
9. Tricuspid valve.
10 Medial cusp.
11. Trabeculæ carneæ.
12. One of the musculi papillares.
13. Chordæ tendineæ.
14. Pulmonary artery.
15. Semilunar valves.
16. Ascending aorta.
17. Arch of the aorta.
18. Descending aorta.

margin of the orifice. Its concave margin is free, the left end of which is attached to the ridge in the atrial septum called the limbus fossa ovalis and the right end is lost on the wall of the atrium. This valve may be cribriform or altogether absent in the adult but is a large structure in the fœtus.

The *valve of the coronary sinus* (Thebesian valve) is a crescentic fold of endocardium guarding the opening of the coronary sinus. Sometimes it is double or is cribriform.

The right atrium is separated from the left atrium by a septum called the *atrial septum.* Upon this partition, above the opening of the inferior vena cava is seen an oval depression, called the *fossa ovalis,* which is bounded above and at the sides by a raised margin. This fossa is the remains of the *foramen ovale* of the fœtus through which the blood passed before birth from the right into the left atrium. The *limbus fossa ovalis* (Annulus ovalis) is the prominent margin which bounds the fossa ovalis ; it is prominent above and at the sides but deficient below.

The *musculi pectinati* are muscular elevations, so named from their resemblance to the teeth of a comb. These are seen in the auricula and in the adjacent anterior wall of the atrium. They terminate in a common vertical ridge, called the *crista terminalis*, which is smooth and muscular.

The *intervenous tubercle* (Tubercle of Lower) is a small elevation on the posterior wall of atrium below the orifice of the superior vena cava. It directs the current of blood from the superior vena cava into the right atrioventricular orifice.

Note that (1) the wall of the right atrium is thin ; (2) the whole of its interior has a shining appearance ; (3) the internal surface of the right atrium is smooth behind the crista terminalis but in front of it presents a contrast owing to a large number of fleshy bands called the musculi pectinati ; (4) the capacity of the right atrium is about two ounces and a half.

The right atrium receives the venous blood returned chiefly by the superior and inferior venæ cavæ. The blood then flows into the right ventricle through the right atrioventricular opening.

Dissection. The right ventricle should now be opened. A triangular flap is to be raised from its anterior wall by making two incisions : (1) from the root of the pulmonary artery downwards towards the incisura apicis cordis at the inferior border of the heart, a little to the right of the anterior longitudinal sulcus ; (2) another incision from the upper end of the first incision carried towards the right a little below the coronary sulcus, terminating

at the right end of the inferior border (Fig. 58). The flap raised should be thrown downwards and fixed with pins. The cavity should be washed clean of all blood and clots.

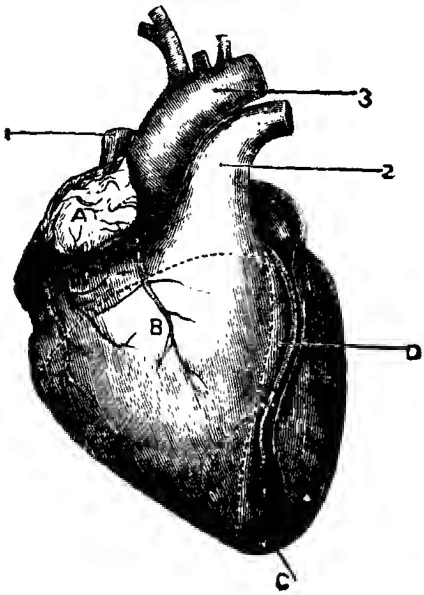


Fig. 58.—Diagram showing how the right ventricle should be opened. The lines of incisions are indicated by the dotted lines.

A. Right atrium.
B. Right ventricle.
C. Apex of the heart.
D. Anterior longitudinal sulcus in which are seen coronary artery and great cardiac vein.
1. Superior vena cava.
2. Pulmonary artery.
3. Aorta.

Right Ventricle.—The cavity of the right ventricle is triangular in form and semilunar on transverse section. Its capacity is about three and a quarter ounces. Its *anterior wall* forms the greater part of the sternocostal surface of the heart. Its *posterior wall* is formed by the septum which separates it from the left ventricle, called the *ventricular septum.* This septum bulges into the cavity of the right ventricle and so on a cross section the cavity would appear semilunar in shape. Its *base* is directed upwards and to the right. At its upper and left part is a conical pouch, called the *conus arteriosus,* which leads to the orifice of the pulmonary artery. The conus arteriosus is connected by its posterior surface to the aorta by a fibrous band called the *tendon of the conus arteriosus.* The *apex* of the right ventricle looks downwards towards the apex of the heart. The following parts are to be studied in the interior of the right ventricle :—(1) right atrioventricular orifice, (2) pulmonary orifice, (3) tricuspid valve, (4) pulmonary semilunar valves, (5) trabeculæ carneæ, (6) chordæ tendineæ.

The *right atrioventricular orifice* allows the passage of blood from the right atrium into the right ventricle. It is an oval

aperture situated at the base of the ventricle, behind the sternum and on a level with the fourth intercostal space. It measures about one inch in diameter being slightly larger than the left atrioventricular orifice and admits the tips of three fingers. It is sourrounded by a fibrous ring to which is attached the tricuspid valve. The pulmonary orifice is situated at the summit of the conus arteriosus and allows the passage of blood from the right ventricle into the lungs through the pulmonary artery for oxygenation. It is situated opposite the upper border of the third costal cartilage of the left side near its junction with the sternum. It is guarded by the pulmonary semilunar valves which are attached to a fibrous ring surrounding the pulmonary orifice.

The *tricuspid valve* is formed by three triangular segments or cusps, which prevent regurgitation of the blood into the right atrium during the contraction of the right ventricle. Like all the valves of the heart, it is formed by a duplicature of the lining membrane, the endocardium, within which is contained a very thin layer of fibrous tissue. The three segments or cusps (anterior, posterior, and medial) are united by their bases and are fixed to a fibrous ring surrounding the atrioventricular orifice, while their apices hang down into the ventricular cavity. The chordæ tendineæ are attached to their apices, adjacent margins and ventricular surfaces. The central part of each cusp is rather thick while the marginal part is thin ; the atrial surface is smooth while the ventricular surface is rough. The *anterior cusp* is situated between the atrial opening and the conus arteriosus ; the *posterior cusp* lies against the wall of the ventricle near the inferior margin of the heart ; and the *medial cusp* (septal cusp) lies against the ventricular septum.

The *pulmonary semilunar valves* are three in number of which two are placed anteriorly and one posteriorly. They are attached by their convex margins to the orifice of the pulmonary artery, while their concave margins are free and directed upwards and present in the centre of each a thickened nodule, the *nodulus of the valve* (corpus Arantii). The fibrous tissue is spread out in each cusp between the two layers of the endocardium throughout its whole extent except along two narrow semilunar areas, one on either side of the central nodule. These semilunar areas of the cusps are called the *lunulæ* which are very thin and consist only of two layers of endocardium. Between the cusps and the wall of the pulmonary artery are three pouches (sinuses of Valsalva).

The inner surface of the right ventricle is smooth in the region of the conus arteriosus but its remaining part presents numerous muscular projections of various length and thickness. These muscular bands are called *trabeculæ carneæ* (Columnæ carneæ) and are of three kinds. The first set forms *ridges* on the ventricular wall being attached to it by their whole length. The second set forms *bridges* being attached to the ventricular wall by their two extremities, the intermediate portion being free. One fleshy band of this group called the *moderator band*, is seen to be attached by one extremity to the ventricular septum and by the other to the base of the anterior papillary muscle. It prevents over-distension of the ventricle. The third set, called the *musculi papillares*, is of considerable size being fixed at one end to the ventricular wall while the other end gives attachment to several fine tendinous cords, the *chordæ tendineæ* which keep the valve in place. The papillary muscles are usually two in number. The anterior muscle is the larger and is attached by its base to the anterior wall of the ventricle ; from its apex the chordæ tendineæ pass to the anterior and posterior cusps of the tricuspid valve. The posterior papillary muscle is fixed by its base to the ventricular septum and the chordæ tendineæ pass from its apex to the posterior and medial cusps of the tricuspid valve. Sometimes the posterior muscle is represented by three or four smaller projections. Some chordæ tendineæ arise directly from the ventricular septum and pass to the anterior and medial cusps.

Dissection. In order to open the left atrium, the heart should be drawn well over to the right side, then an incision should be made on the posterior surface of the atrium from the pulmonary veins of the left side to those of the right side, and another from the middle of the first incision to the tip of the auricula (Fig. 59).

The **Left Atrium** is smaller than the right but its walls are a little thicker. It is concealed by the aorta and the pulmonary artery. Like the right atrium it consists of a main cavity and an auricula. The latter is longer and more curved than the auricula of the right atrium and projects to the right overlapping the root of the pulmonary artery. The interior of the left atrium presents for examination : (1) the orifices of the four pulmonary veins, (2) the left atrioventricular orifice, (3) the orifices of the venæ cordis minimæ, and (4) musculi pectinati.

The *orifices of the four pulmonary veins* are seen on the poste-

rior wall of the atrium. Oxygenated blood from the lungs is brought into the left atrium by the pulmonary veins. The two left pulmonary veins often open by a common orifice. These orifices are not guarded by valves. The *left atrioventricular orifice* is placed in the lower and posterior part of the ventricle. It is smaller than the right atrioventricular orifice. It admits the tips of two fingers. It is guarded by the bicuspid or mitral valve. The *orifices of the venæ cordis minimæ* are fewer than those in the right atrium.

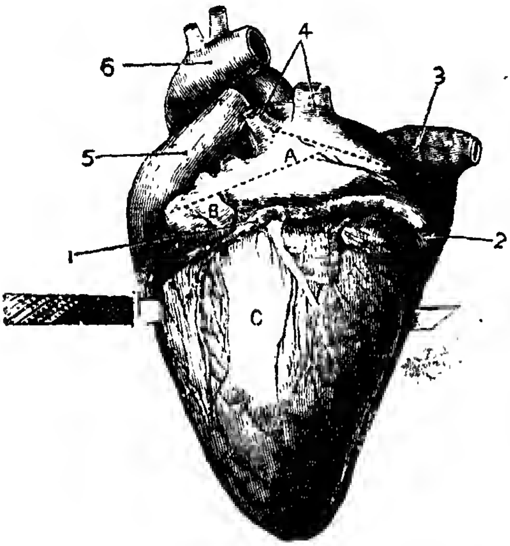


Fig. 59.—Diagram showing how the left atrium and left ventricle should be opened. The dotted lines indicate the directions for opening the left atrium. The wall of the left ventricle is seen to be transfixed by a knife.

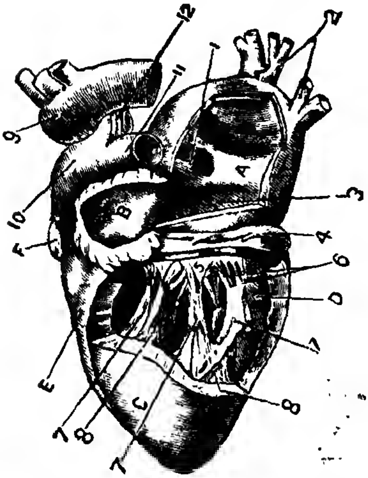
A. Left atrium.
B. Left auricula.
C. Left ventricle.
1. Great cardiac vein.
2. Coronary sinus.
3. Right pulmonary vein.
4. Two left pulmonary veins.
5. Pulmonary artery.
6. Aortic arch.

The *musculi pectinati* are smaller and fewer than those in the right atrium and are limited to the auricula only

The right atrium is separated from the left by a fibromuscular partition called the *atrial septum*; on it a small depression is sometimes seen bounded below by a semilunar ridge. This depression corresponds to the fossa ovalis seen on the other side of the septum.

Dissection. To examine the interior of the left ventricle, a triangular flap is to be raised from its wall with the apex below (Fig. 59). The ventricle is to be transfixed a little to the left of the anterior longitudinal sulcus below the coronary sulcus and the knife pushed till its point pierces the posterior wall a little to the left of the posterior longitudinal sulcus. The knife is then to be carried downwards towards the apex.

The **Left Ventricle** is conical in shape; its cavity is oval or circular on transverse section; its walls are three times as



A. Cavity of the left atrium.
B. Cavity of the auricula in which are seen the musculi pectinati.
C. Left ventricle.
D. Cavity of the left ventricle.
E. Right ventricle.
F. Apex of the right auricula.
1. Opening of the two right pulmonary veins.
2. Left pulmonary veins.
3. Auriculo-ventricular opening.
4. Coronary sinus.
5. Mitral valve.
6. Chordæ tendineæ.
7. Musculi papillares.
8. Trabeculæ carneæ.
9. Aortic arch.
10. Pulmonary artery.
11. Left pulmonary artery.
12. Ligamentum arteriosum.

Fig. 60.—The interior of the left atrium and left ventricle.

thick as those of the right ventricle. The following parts require to be examined in its interior:—(1) The left atrioventricular opening and (2) mitral valve; (3) the aortic opening and (4) aortic semilunar valves; (5) the trabeculæ carneæ and (6) chordæ tendineæ.

The *left atrioventricular orifice* is situated below and to the left of the aortic orifice. It is situated behind the left margin of the sternum on a level with the fourth left costal cartilage. It is surrounded by a fibrous ring to which the mitral valve is attached.

The *mitral* or *bicuspid valve* is similar in structure to the tricuspid valve but consists of two cusps which are larger and thicker than those of the tricuspid valve. The *anterior* or *aortic cusp* is larger than the posterior and lies in front and to the right of the atrioventricular orifice. The *posterior cusp* lies behind and to the left of the atrioventricular opening The free margins of the cusps and their ventricular surfaces give attachment to the chordæ tendineæ which are thicker and stronger than those of the tricuspid valve.

The *aortic orifice* is situated in front and to the right of the left atrioventricular orifice. It is guarded by the aortic semi-

lunar valves. The portion of the ventricular cavity just below the aortic orifice is called the *aortic vestibule* and is destitute of muscular tissue.

The *aortic semilunar valves* are three in number of which two are posterior (right and left) and one anterior. They are larger and thicker than the pulmonary semilunar valves. The nodules at the free margins of the valves are more prominent and the lunulæ are more distinctly seen. The pouches between the cusps and the wall of the aorta, called the *aortic sinuses* (sinuses of Valsalva), are larger than those of the pulmonary artery; moreover the orifices of the coronary arteries are seen in these sinuses. The right coronary artery arises from the anterior aortic sinus while the left from the left posterior sinus.

The *trabeculæ carneæ* are of three kinds as in the right ventricle; but they are more numerous and form a very dense network upon the posterior wall of the ventricle and at the apex but on the septum and anterior wall they are not prominent. The *musculi papillares* are thicker and stronger than those in the right ventricle. They are two in number; one is attached to the anterior wall

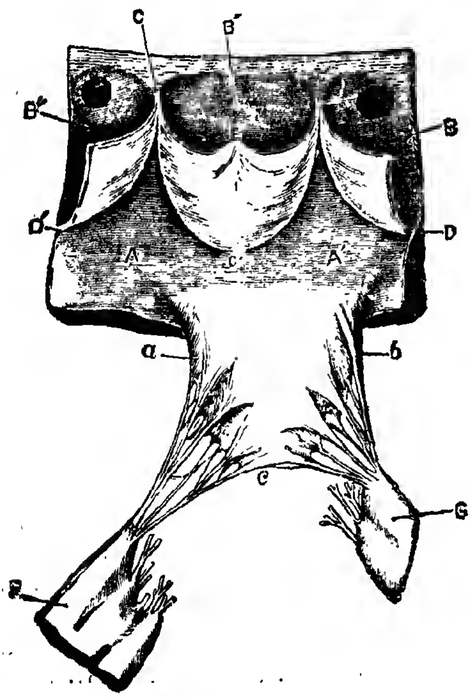


Fig. 61.—Diagram to illustrate the attachments of one cusp of the mitral valve and the aortic valves.

A, A′. Portion of the ventricular wall and B. B′. B″. aorta.
B. B′. B″. Sinuses of aorta in B and B″, openings of coronary arteries are seen.
C. C. } D. D′. } Attached border of semilunar valve.
E. Nodule of the valve seen in the middle of the free border of the valve. The lunulæ are seen on either side of E.
F. G. Musculi papillares.
a. b, c. Attachment of the chordæ tendineæ.

and the other to the posterior wall of the ventricle. They give attachment to the chordæ tendineæ by their free rounded extremities. The chordæ tendineæ from each papillary muscle are attached to the margins and ventricular surfaces of both cusps of the mitral valve.

A fibro-muscular partition is placed between the right and left ventricles called the *ventricular septum;* it is thick and muscular at its lower part but thin and membranous at its upper part. The thin upper portion consists only of fibrous tissue covered by endocardium and is called the *pars membranacea septi*. It constitutes a part of the wall of the aortic vestibule. The lower portion of the septum is specially thick near the apex of the heart. The anterior margin of the septum is attached opposite the anterior longituninal sulcus and the posterior margin opposite the posterior longitudinal sulcus. The septum bulges into the right ventricle, hence the cavity of the right ventricle is semilunar on section and that of the left ventricle is circular.

Surface Anatomy of the Heart.—The extent of the heart in relation to the front of the thorax is indicated thus :—The *apex* is determined by taking a point in the left fifth intercostal space, three and a half inches (9 cm.) to the left of the midsternal line ; from this point a line drawn to the seventh right sterno-costal articulation across the junction of the xiphoid process with the body of the sternum, indicates the *lower border* of the heart. A line drawn from the seventh right sterno-costal articulation to the upper border of the third right costal cartilage half an inch from the right border of the sternum, with its convexity to the right indicates the *right border* of the heart. A line drawn from the apex of the heart to the lower border of the second left costal cartilage one inch from the left border of the sternum, with its convexity to the left indicates the *left border* of the heart. A line drawn from the lower border of the second left costal cartilage one inch from the left border of the sternum to the upper border of the third right costal cartliage half an inch from the right border of the sternum, indicates the *upper border* of the heart. The orifices of the heart are indicated on the surface thus :—The *pulmonary orifice* is the highest and placed at the upper limit of the third left sterno-costal articulation; the *aortic orifice* is a little lower and medial to this, being quite close to the same articulation ; the *left atrio-ventricular orifice* is situated below the aortic orifice and lies opposite the left fourth costal cartilage close to the left border of the sternum ; the

right atrio-ventricular orifice is placed below and to the right and lies opposite the fourth right intercostal space behind the right half of the sternum.

The great vessels of the heart are now to be carefully cleaned and examined.

The **Superior Vena Cava** is a short trunk about three inches in length. It is formed behind the first right costal cartilage close to the sternum by the junction of the two innominate veins. It descends vertically, pierces the pericardium and opens into the upper and back part of the right atrium behind the third costal cartilage. In the *upper half* of its course it lies in the superior mediastinal space, the right mediastinal pleura and the right phrenic nerve being placed on its right side; while on its left side, is the innominate artery. In the *lower half* of its course, it is enclosed within the fibrous layer of the pericardium and lies in the middle mediastinal space; the serous layer of the pericardium covers this portion in front and at the sides; the ascending aorta is placed on its left side, while the right pulmonary artery and the upper right pulmonary vein lie behind it.

Tributaries.—The superior vena cava receives the two innominate veins, and a large vein viz., the azygos vein immediately before it pierces the pericardium. Besides this large tributary several small mediastinal and pericardiac veins pour their contents into it.

The **Inferior Vena Cava** has a very short course (about three fourths of an inch or 2 cm.) in the thoracic cavity. If the heart is lifted up, the vein will be seen to enter the pericardium after piercing the central tendon of the diaphragm. It opens into the lower and back part of the right atrium.

The **Pulmonary Artery** is a short vessel, about two inches in length. It arises from the summit of the conus arteriosus and passes upwards and backwards at first in front of and then to the left side of the ascending aorta. It then divides opposite the fibrocartilage between the fifth and sixth thoracic vertebræ into a right and a left pulmonary artery. The serous layer of the pericardium encloses this vessel and the ascending aorta in a common tubular sheath. The right auricula and the right coronary artery lie to the right side of the vessel, while the left auricula and the left coronary artery lie to its left side.

The *right pulmonary artery* is longer and larger than the left. It passes lateralwards to the right behind the ascending aorta and the superior vena cava to the hilum of the right lung forming

one of the constituents of its root. It divides into an upper and a lower branch. The upper is the smaller branch and passes in company with the eparterial bronchus and is distributed to the upper lobe of the right lung; the lower one is the larger branch and is distributed to the middle and lower lobes.

The *left pulmonary artery* passes lateralwards to the left in front of the descending aorta and the left bronchus to the hilum of the left lung, forming one of the constituents of its root. It divides into two branches, an upper and a lower, which are distributed to the upper and lower lobes of the left lung. The root of the left pulmonary artery is connected to the under surface of the left part of the aortic arch by a short fibrous cord called the *ligamentum arteriosum*. It is the remains of a vessel, called the ductus arteriosus, which during fœtal life conveys the blood from the pulmonary artery to the aorta.

Pulmonary Veins.—The tributaries of the pulmonary veins arise from the capillaries in the walls of the alveoli of the lungs. The smaller veins unite to form larger vessels which again unite to form a single vein for each lobe of the lung. The vein from the middle lobe of the right lung joins with that from the upper lobe before the latter reaches hilum pulmonis. In this way four terminal pulmonary veins are formed, two for each lung. The *right pulmonary veins* pass behind the superior vena cava and the right atrium, and open separately into the upper and back part of the left atrium. The *left pulmonary veins* pass in front of the descending aorta and open into the left atrium usually by separate orifices or sometimes by one common orifice. The relation of the pulmonary veins to the other constituents of the pulmonary root has been described.

Thymus.—Mention has been made of the remains of the thymus gland. The student should refer to a dissected fœtus for studying this organ. It attains its maximum size at puberty. It then begins to dwindle and in the adult is usually represented by some connective tissue covering the great vessels of the superior mediastinum. The fully developed gland is of a pinkish grey colour and consists of two lateral lobes which extend above for a varying distance in the neck up to the lower end of the thyreoid gland and below as far as the level of the fourth costal cartilage.

The **Aorta** is the great arterial trunk from which all the arteries of the body derive oxygenated blood. It begins at the aortic orifice of the left ventricle and ascends obliquely to the **right**

behind the sternum as far as the second right costal cartilage. This portion is called the *ascending aorta.* Then it arches backwards and to the left and reaches the lower border of the body of the fourth thoracic vertebra on its left side forming the *arch of the aorta.* Finally it descends within the thorax on the left side of the bodies of the thoracic vertebræ and enters the aortic opening in the diaphragm. This portion is called the thoracic portion of the *descending aorta.*

The **Ascending Aorta** is enclosed by the serous layer of the pericardium in a tubular sheath common to it and the pulmonary artery. It presents three small dilatations at its commencement called the *aortic sinuses.* There is a fourth dilatation where it terminates in the arch of the aorta and is called the *bulb of the aorta* or the *great sinus of the aorta.* Its commencement is *covered* by the pulmonary artery and higher up it is overlapped by the anterior margin of the right lung and right pleura. The right atrium and the superior vena cava lie on its *right side.* The pulmonary artery lies on its *left side* at a higher level. *Posteriorly* it is in relation with the left atrium and the right pulmonary artery.

Branches.—These are the right and left coronary arteries and have been already studied.

The **Arch of the Aorta** lies in the superior mediastinum behind the manubrium sterni. *In front* it is covered by the pleuræ and lungs. It is crossed vertically along its left part by the left vagus and left phrenic nerves, the inferior cervical cardiac branch of the left vagus and the superior cervical cardiac branch of the left sympathetic nerve and the left superior intercostal vein. *Behind* it are the trachea, the œsophagus, the thoracic duct, the left recurrent nerve and the deep cardiac plexus. *Above* it is in relation with the innominate vein and gives origin to the innominate, left common carotid and left subclavian arteries. *Below*, in the concavity of the arch are the superficial cardiac plexus, the left recurrent nerve, the bifurcation of the pulmonary artery, the left bronchus, and the ligamentum arteriosum.

Branches.—These are (1) the innominate, (2) the left common carotid, and (3) the left subclavian.

Directions. The student will do well if he studies now the dissected heart of the fœtus noting the foramen ovale and the patent ductus arteriosus connecting the left pulmonary artery to the left side of the aortic arch.

The innominate veins and the branches of the arch of the aorta should now be properly cleaned and studied.

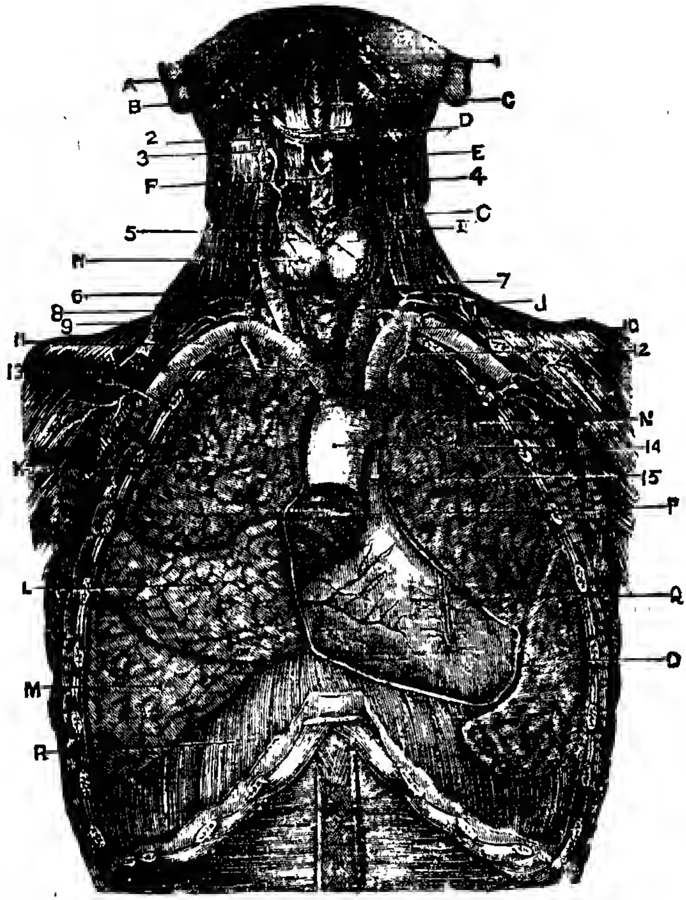


Fig. 62.—Dissection of the large vessels of the thorax and lower part of the neck.

A. Digastric.
B. Submaxillary gland.
C. Mylo-hyoid.
D. Hyoid bone.
E. Thyreo-hyoid.
F. Thyreoid cartilage.
G. Crico-thyreoid muscle.
H. Thyreoid gland.
I. Cricoid cartilage.
J. Trachea.
K. Right lung (upper lobe).

1. Submental branch of external maxillary artery.
2. External carotid artery.
3. Internal carotid artery.
4. Superior thyreoid artery.
5. Right common carotid artery.
6. Inferior thyreoid artery.
7. Left common carotid artery.
8. Thyreo-cervical trunk.
9. Vertebral artery.
10. Left subclavian artery.

L. Right lung (middle lobe).
M. Right lung (lower lobe).
N. Left lung (upper lobe).
O. Left lung (lower lobe).
P. Right atrium.
Q. Right ventricle.
R. Diaphragm.
11. Right subclavian artery.
12. Internal mammary artery.
13. Innominate artery.
14. Arch of aorta.
15. Pulmonary artery.

The **Innominate Veins** are two in number, a right and a left. They are formed behind the sternal ends of the clavicles by the junction of the internal jugular and subclavian veins.

The **Right Innominate Vein** is about an inch (2.5 cm.) in length. It passes downwards and slightly medialwards and unites with the left innominate vein to form the superior vena cava. On its *right side* is the right phrenic nerve. On its *left side* is the innominate artery. *In front* it is covered by pleura and *behind* it is the right vagus nerve.

The **Left Innominate Vein** is about three inches (7 cm.) in length. It passes obliquely downwards and to the right to unite with the right innominate vein. *In front* of it are the sterno-hyoid and sterno-thyreoid muscles and the remains of the thymus gland. *Behind* it are the innominate, left common carotid and left subclavian arteries, the left vagus and phrenic nerves.

Tributaries of the right and left innominate veins.—

The right innominate vein receives :—	The left innominate vein receives :—
1. The right vertebral vein.	1. The left vertebral vein.
2. The right internal mammary vein.	2. The left internal mammary vein.
3. The right inferior thyreoid vein.	3. The left inferior thyreoid vein.
4. The first right intercostal vein.	4. The first left intercostal vein.
	5. The left superior intercostal vein.
	6,7. Some pericardiac and thymic veins.

The **Innominate Artery** is the largest branch of the arch of the aorta. It ascends obliquely to the right and divides behind the upper border of the right sterno-clavicular articulation into the right common carotid and the right subclavian arteries. *In front* it has the manubrium sterni, the origins of the sterno-

hyoid and sterno-thyreoid muscles, the left innominate vein and the remains of the thymus gland. *Behind* it, is the trachea which is crossed by it obliquely. *On its right side* are the right innominate vein, the pleura and the right phrenic nerve; on its *left side* are the left common carotid artery below and the trachea above.

Branches.—Usually no branch is given off from the innominate artery but occasionally a small artery, the *thyreoidea ima* arises from it and passes in front of the trachea to supply the thyreoid gland.

The **Left Common Carotid Artery** arises from the arch of the aorta to the left of, and posterior to, the innominate artery. It consists of a thoracic portion and a cervical portion. The *thoracic portion* extends from the arch of the aorta to the left sterno-clavicular articulation. *In front* of it are the sternum, the origins of the left sterno-hyoid and sterno-thyreoid muscles, the left innominate vein and the remains of the thymus gland. *Behind* it has at first the trachea, and higher up, the œsophagus, the left recurrent nerve and the thoracic duct. To its *right side* is the innominate artery below and the trachea higher up. To its *left side* are the left pleura and the left vagus nerve.

The **Left Subclavian Artery** issues from the aortic arch behind the left common carotid. It consists of a thoracic and a cervical portion. The *thoracic portion* extends from the aortic arch to the back part of the sternal end of the clavicle. *In front* it has the left common carotid artery, the left innominate vein and the left vagus nerve. *Behind* it are the œsophagus and the thoracic duct. To its *right side* it has the trachea and the left recurrent nerve below and the œsophagus and the thoracic duct above. To its *left side* are the left pleura and left lung. No branch is given off from the thoracic portion of the artery.

Dissection. Divide the superior and inferior venæ cavæ close to the heart as also the pulmonary artery and the pulmonary veins. The ascending aorta is to be severed at its junction with the arch of the aorta. The heart can now be removed from the body and its structure should be studied as far as it is possible in the dissecting-room.

Structure of the Heart.—The external surface of the heart is covered by the visceral layer of the serous pericardium, called the *epicardium.* Its cavities are lined by a smooth membrane called the *endocardium* which is continuous with the inner coat of the blood vessels entering and leaving the organ. Between

these two membranes is the *myocardium* or the muscular wall of the heart. In addition to these structures there exist four fibrous rings surrounding the four orifices viz., the two atrio-ventricular and two arterial orifices(the aortic and the pulmonary). The *atrio-ventricular rings* are interposed between the muscle fibres of the atria and the ventricles and give attachment to those muscular fibres as also to the tricuspid and mitral valves. The *aortic* and *pulmonary rings* are interposed between the muscle fibres of the ventricles and the muscular coats of the arteries, and the semilunar valves are attached to them. To examine the muscular fibres of the heart, a goat's heart (fresh), which can be easily procured, should be boiled for about half an hour so as to dissolve the connective tissue. It will then be seen that the *fibres of the atria* are distinct from those of the ventricles. The former are arranged in two layers, a superficial and a deep. The superficial layer runs transversely encircling both the atria. The deep layer runs antero-posteriorly from the atrioventricular rings and is limited to each atrium. This layer is arranged circularly around the auricula, the fossa ovalis and the openings of the veins. The *fibres of the ventricles* are also arranged in two layers, a superficial and a deep. The superficial fibres common to both cavities begin at the atrioventricular rings and pass obliquely downwards to the apex. Fibres passing from the right atrio-ventricular ring pass downwards and to the left across the anterior longitudinal sulcus to the apex of the left ventricle while those from the left atrio-ventricular ring pass across the diaphragmatic surface of the heart downwards and to the right to the apex of the right ventricle. Reaching the apices of the two ventricles they are coiled and form two vortices, one at each apex. Then they pass upwards along the inner aspect of the walls of the ventricles to the bases of the papillary muscles of their respective ventricles. The deep fibres are arranged in ∽—shaped manner and connect the papillary muscles of one ventricle with that of the other by dipping at the longitudinal sulcus.

Atrioventricular bundle. (Fig. 63).—Remove the medial cusp of the tricuspid valve by detaching it from the fibrous ring which surrounds the right atrioventricular opening. Peel off the endocardium from the upper part of the ventricular septum near its posterior margin. A bundle of pale muscle fibres will be seen passing from the atrial septum near the opening of the coronary sinus to the ventricular septum. After crossing the

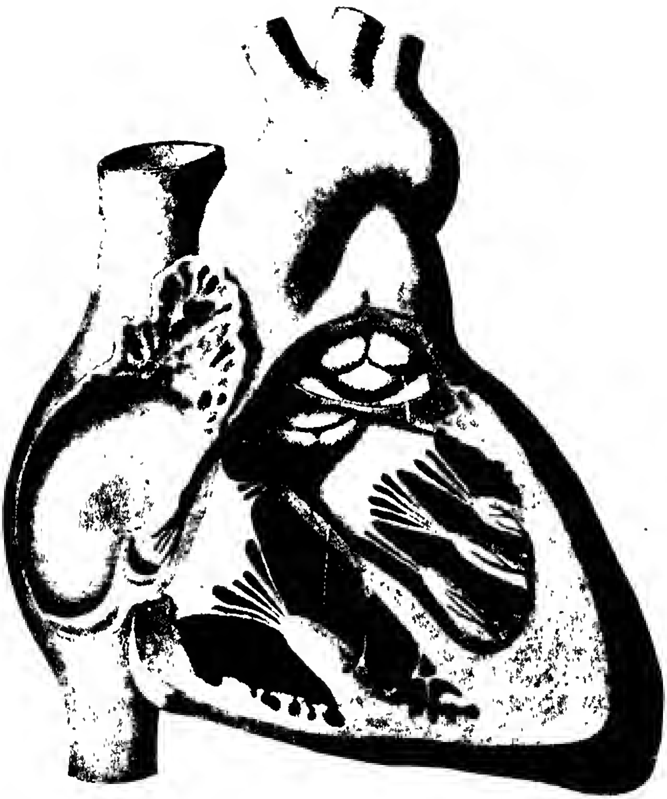


Fig. 63.—Schematic representation of the atrioventricular bundle The course of the bundle is represented in red. (After Gray).

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membranous part of the latter septum the bundle divides into two branches, a right and a left. The right branch passes over the right surface of the septum along the moderator band to the anterior papillary muscle, the left branch passes over the left surface of the septum and ends at the base of the anterior papillary muscle. Offsets are given off from both the branches to the walls of the ventricles. This bundle is called the *atrio-ventricular bundle* and establishes direct muscular continuity between the atria and the ventricles for the propagation of the wave of contraction.

Dissection. The ligamentum arteriosum is to be divided and the arch of aorta to be hooked forwards and to the left. The deep cardiac plexus is now exposed.

The **Deep Cardiac Plexus** is situated behind the arch of the aorta and in front of the trachea at its bifurcation. It consists of a right portion and a left portion which are united with each other by communicating twigs. The *right portion* of the plexus is formed by (1) the three cardiac branches derived from the three cervical ganglia of the right sympathetic trunk, (2) the cervical and thoracic cardiac branches of the right vagus nerve, and (3) the cardiac branches of the right recurrent nerve. It distributes branches to the right anterior pulmonary plexus, the right atrium, the right coronary plexus, and to the superficial cardiac plexus. The *left portion* of the plexus is formed by (1) the middle and lower cardiac branches of the sympathetic trunk of the left side of the neck, (2) the upper cervical cardiac branch of the left vagus nerve, and (3) the cardiac branches of the left recurrent nerve. It distributes branches to the left anterior pulmonary plexus, the left atrium and the left coronary plexus.

The thoracic portion of the trachea should now be examined.

The **Trachea** is a wide tube which serves as the common air passage to both lungs, and is from four to four and a half inches in length. Its wall is formed partly by cartilage and partly by membrane. The cartilaginous rings occupy the front and side walls of the tube and are incomplete behind where the tube is completed by fibro-muscular membrane. In the thorax it passes through the back part of the superior mediastinal space and extends from the upper margin of the manubrium sterni to the upper border of the fifth thoracic vertebra where it bifurcates into the right and left bronchi. It lies in the median plane but its lower end is inclined to the right side. The thoracic

part of the trachea has *in front* the manubrium sterni, the origins of the sterno-hyoid and sterno-thyreoid muscles, the left innominate vein, the arch of the aorta, the commencement of the innominate and the left common carotid arteries and the deep cardiac plexus. *Behind* it, is the œsophagus. On the *right side* are the pleura, the right vagus nerve and the terminal part of the innominate artery: on the *left side* are the arch of the aorta, the left common carotid and left subclavian arteries, and the left recurrent nerve.

The **Right Bronchus** is wider but shorter than the left, and is about an inch (2.5 cm.) in length. It passes almost vertically to the hilum of the right lung and about three-fourths of an inch from its origin gives off a branch to the upper lobe of the right lung; this branch is called the *eparterial branch*, in consequence of its being given off above the pulmonary artery. The bronchus then passes behind and below the artery and divides into two branches for the middle and lower lobes of the right lung; these branches are called *hyparterial branches* because they lie below the pulmonary artery. The azygos vein passes over the right bronchus to end in the superior vena cava.

The **Left Bronchus** is narrower and longer than the right and is about two inches in length. It passes obliquely downwards and lateralwards beneath the arch of the aorta, crosses the œsophagus and the descending aorta and reaches the hilum of the left lung, behind and below the left pulmonary artery. It divides into two branches for the two lobes of the left lung. As the pulmonary artery is placed above the bronchus in the hilum of the left lung, the branches of the left bronchus are called *hyparterial branches*.

Around the bifurcation of the trachea and along the bronchial tubes are many lymph glands called the *tracheo-bronchial lymph glands*. These lymph glands often contain black pigment. Their afferents are derived from the thoracic portion of the trachea and the bronchi, from the lungs and the heart. Their efferents pass to the broncho-mediastinal lymph trunk on each side.

Remove the anterior wall of the trachea above the point of its bifurcation and note that the projecting septum which lies between the orifices of the two bronchi is inclined more to the left. For this reason and for the more vertical course of the right bronchus a foreign body dropped into the trachea would pass readily into the right bronchus.

Dissection. The student should now dissect and study the

structures which are contained in the posterior mediastinal space. The right lung is to be drawn out of its cavity and hooked towards the left side of the thorax. The pleura of the right side is to be removed from the posterior wall of the thorax, and from the posterior surface of the root of the right lung. A similar dissection is to be made on the left side by drawing out and hooking the left lung towards the right side of the thorax and stripping the parietal pleura from the inner surface of the ribs, the intercostal muscles and the sides of the vertebræ. Clean the thoracic portion of the œsophagus taking care of the plexus of nerves surrounding its lower part. The vagus nerve is seen behind the root of the lung; trace it above and below and on each side; next find the branches given off from it. Trace one or two inferior cardiac branches of the right vagus nerve to the deep cardiac plexus. Trace the left recurrent nerve as it hooks below the left part of the arch of the aorta. Look for the pulmonary branches opposite the roots of the lungs and follow them to both the anterior and posterior pulmonary plexuses. Œsophageal branches are given off both above and below the roots of the lungs. The latter are to be followed to the œsophageal plexus around the œsophagus. The azygos vein is to be traced along the right side of the vertebral column from the aortic orifice in the diaphragm. The hemiazygos vein is to followed along the left side of the lower part of the thoracic portion of the vertebral column. Note that it crosses the vertebral column to the right at about the level of the eighth thoracic vertebra to open into the azygos vein. Note also the intercostal veins of the lower three spaces on the left side which form its tributaries. The accessory hemiazygos vein descends along the left side of the upper thoracic vertebræ and crosses the vertebral column to the right above the hemiazygos vein to open into the azygos vein. Note its tributaries formed by some of the upper intercostal veins of the left side. The thoracic duct is seen to come up through the aortic opening of the diaphragm and lies on the right side of the aorta; it should be followed upwards behind the œsophagus to the aortic arch. Behind the arch it ascends along the left side of the œsophagus in the superior mediastinum. It should be followed further upwards till its continuity is established in the neck where it has been displayed by the dissector of the head and neck. The thoracic portion of the descending aorta and its intercostal branches which can be examined at this stage are to be dissected.

When the above named structures have been dissected out and studied the sympathetic nerve trunk, which is seen to lie over the heads of the ribs, is to be cleaned; paired branches which connect its ganglia with the intercostal nerves are to be followed and other branches are to be traced, specially the three splanchnic nerves which proceed downwards to the abdomen from the lower seven ganglia.

Posterior Mediastinum. (Fig. 65).—The boundaries of this space have been described (p. 150). The contents of the posterior mediastinum may be tabulated in the following order :—

Vessels	1. Thoracic part of descending aorta. 2. Azygos vein. 3. Hemiazygos vein. 4. Accessory hemiazygos vein. 5. Thoracic duct.
Nerves	1, 2. Right and left vagus nerves. 3, 4. Right and left splanchnic nerves.
Other structures	Œsophagus. Lymph glands.

Œsophagus or **Gullet.**—The thoracic portion of the œsophagus descends through the superior and posterior mediastinal spaces, pierces the diaphragm and terminates in the stomach opposite the tenth thoracic vertebra. In its course through the thorax it presents two curves. In the superior mediastinum it lies to the left of the median line of the vertebral column. But at the level of the fifth thoracic vertebra, it comes to the median line. Lower down it again inclines to the left of the middle line before passing through the diaphragm. The thoracic portion of the œsophagus presents two constrictions: one at the level of the left bronchus and the other at the œsophageal opening of the diaphragm. *In front* of it are the trachea, the left bronchus, the pericardium, and the diaphragm. *Behind* it are the left longus colli muscle, the vertebral column, the azygos, hemiazygos and accessory hemiazygos veins, the right aortic intercostal arteries, the thoracic duct, and the lower part of the thoracic aorta. On its *right side* are the azygos vein and mediastinal pleura. On its *left side* are the left subclavian artery, the upper part of the thoracic duct, and the mediastinal pleura above, and the descending thoracic aorta, and the mediastinal pleura again below.

Below the roots of the lungs the œsophagus is encircled by the œsophageal plexus formed by the breaking up into a large number of branches of the two vagi nerves on it. But before the œsophagus passes through the diaphragm these branches are

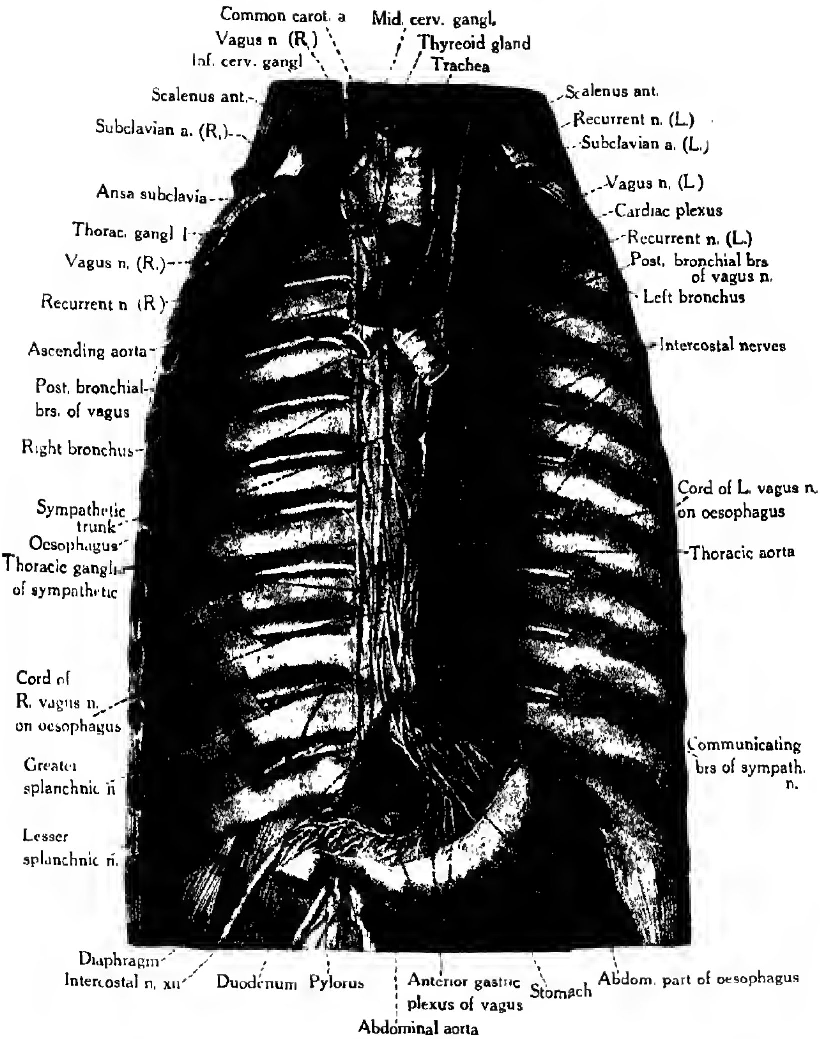

Fig. 64.—The course and distribution of the right and left vagus nerves (Sobotta).

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collected into two nerve trunks, the left and right vagi nerves; the former occupies the anterior and the latter the posterior aspect of the gullet.

Vagus Nerve (Pneumogastric nerve) (Fig. 64).—The vagi nerves differ in their course in the thorax on the two sides, but both of them pass through the superior and posterior mediastinal spaces. The *right vagus nerve* on entering the thorax passes behind the right innominate vein and along the right side of the trachea giving off near its bifurcation the anterior pulmonary branches. It then passes to the back of the root of the right lung, where it breaks up into several branches, which unite with filaments from the sympathetic trunk forming the posterior pulmonary plexus. From the lower part of this plexus two cords (sometimes one cord) issue and descend upon the œsophagus upon which they give off several branches which unite with the corresponding branches of the left vagus nerve to form the œsophageal plexus. From this plexus the right vagus nerve issues as a single trunk which gains the posterior surface of the œsophagus before it enters the œsophageal opening of the diaphragm

The *left vagus nerve* on entering the thorax lies between the left common carotid and the left subclavian arteries. Then it crosses the arch of the aorta and gives off its recurrent branch below the arch. Then it passes to the back part of the root of the left lung, where it breaks up into several branches which unite with filaments from the sympathetic trunk forming the posterior pulmonary plexus. From the lower part of this plexus two cords issue and descend upon the œsophagus and give off several branches which unite with the corresponding branches of the right vagus nerve forming the œsophageal plexus. From this plexus the left vagus nerve emerges as a single trunk which gains the anterior aspect of the œsophagus before it leaves the thorax.

Branches.—Each vagus nerve gives off the following branches in the thorax:—(1) The *anterior pulmonary branches* which are two or three filaments. They pass to the anterior aspect of the root of the lung, unite with filaments from the sympathetic trunk and form the *anterior pulmonary plexus*. (2) The *posterior pulmonary branches* are several large filaments which join with branches from the third and fourth ganglia of the sympathetic trunk forming the *posterior pulmonary plexus*. Filaments are given off from this plexus to supply the bronchi

and lungs. (3) The *œsophageal branches* join with branches from the opposite nerve and form the *œsophageal plexus* and supply the œsophagus and the back part of the pericardium. The right vagus nerve gives off one or two *cardiac branches* which join the deep cardiac plexus. The left vagus nerve gives off *the recurrent nerve* (recurrent laryngeal nerve) which arises after the trunk has crossed the arch of the aorta. The *left recurrent nerve* winds round the lower border of the aortic arch lateral to the ligamentum arteriosum and ascends along the left side of the trachea between it and the œsophagus. It gives off some cardiac branches which join the left part of the deep cardiac plexus.

The **Azygos Vein** (Vena azygos major) (Fig. 65) enters the thorax through the aortic opening of the diaphragm. Then it ascends along the right side of the vertebral column to the posterior aspect of the root of the right lung, and gaining its upper border arches forwards to open into the superior vena cava before it pierces the pericardium. In its course it lies upon the right intercostal arteries and is placed on the right side of the thoracic duct and the thoracic portion of the descending aorta.

Tributaries.—The azygos vein receives (1) the right subcostal vein, (2) the lower eight intercostal veins of the right side, (3) the right superior intercostal vein, (4) the hemiazygos vein, (5) the accessory hemiazygos vein, (6) the right bronchial veins, (7) the œsophageal veins and (8) the pericardiac veins

Thoracic Duct (Fig. 65).—While dissecting the posterior abdominal wall the student has noticed that the thoracic duct begins in the abdomen in a dilatation called the cisterna chyli in front of the first and second lumbar vertebræ. On entering the thorax through the aortic opening of the diaphragm it lies to the right side of the aorta between it and the azygos vein. It ascends through the posterior mediastinum behind the œsophagus and in front of the vertebral column in the middle line crossing the right aortic intercostal arteries. At the level of the fifth thoracic vertebra it passes to the left of the middle line behind the arch of the aorta and ascends through the superior mediastinum to the root of the neck behind the left subclavian artery and on the left side of the œsophagus. Reaching the seventh cervical vertebra it arches lateral wards behind the internal jugular vein to terminate at the angle of junction of this vein with the left subclavian vein. It is provided with valves which are placed at short intervals.

The thoracic duct sometimes divides in the middle of its course into two which unite again, or divides into several branches which communicate with one another forming a plexus.

Tributaries.—In the thorax the thoracic duct receives lymphatics from the left half of the thoracic cavity including the wall and viscera.

The *right broncho-mediastinal lymph trunk* is a small lymph vessel which ascends from the fifth thoracic vertebra to the root of the neck on the right side. It opens either into the right innominate vein or joins the right subclavian and jugular lymph trunks to form a short vessel, the *right lymph duct*, which opens at the junction of the right internal jugular and subclavian veins like the thoracic duct on the left side. The right broncho-mediastinal lymph trunk receives lymphatics from the upper part of the right lobe of the liver and the right half of the thoracic cavity including the right side of the heart and the right lung and pleura.

Descending Aorta.—The thoracic portion of the descending aorta is the continuation downwards of the arch of the aorta. It begins at the lower border of the fourth thoracic vertebra on its left side and descending through the posterior mediastinum ends in the aortic opening of the diaphragm opposite the lower border of the twelfth thoracic vertebra. Thence it is continued downwards as the abdominal aorta. At its commencement it lies to the left of the vertebral column but gradually approaches the median line. *In front* it has the root of the left lung, the pericardium, the œsophagus and the crura of the diaphragm, in that order from above downwards. *Behind* it are the vertebral column, the hemiazygos and accessory hemiazygos veins. On its *right side* are the œsophagus (above), the azygos vein and the thoracic duct. On the *left side* it has the mediastinal pleura, the left lung and the œsophagus (below).

Branches.—(1) *Intercostal* and (2) *subcostal arteries*. These will be examined later. (3) *Bronchial arteries*. These have been described (p. 155). (4) *Pericardiac branches*. These are a few twigs distributed to the back part of the pericardium. (5) *Œsophageal branches*. These are four or five in number and ramify in the wall of the œsophagus and anastomose above with the œsophageal branches of the inferior thyreoid artery and below with the œsophageal branches of the left gastric artery. (6) *Posterior mediastinal branches*. These are minute twigs which supply the areolar tissue and lymph glands of the posterior

mediastinum. (7) *Superior phrenic branches*. These are a few twigs which issue from the lower part of the thoracic aorta and supply the posterior part of the upper surface of the diaphragm.

Thoracic Lymph Glands.—Of these (1) the *sternal* or *internal mammary lymph glands* which accompany the internal mammary artery, (2) the *lower anterior mediastinal lymph glands* which lie in the lower portion of the anterior mediastinum, (3) the *tracheo-bronchial glands* which lie in and around the bifurcation of the trachea and the bronchi have been examined. (4) The *broncho-pulmonary lymph glands* lie in the hilum of each lung. (5) The *pulmonary lymph glands* lie in the substance of the lung on the branches of the bronchi. (6) The *upper anterior mediastinal lymph glands* lie in the anterior part of the superior mediastinum in front of the arch of the aorta and in relation with its three branches. They receive lymph vessels from the pericardium, the heart and the thymus. Their efferents open into the broncho-mediastinal lymph trunk. (7) The *posterior mediastinal lymph glands* lie by the side of the descending thoracic aorta and receive lymph vessels from the pericardium, œsophagus, diaphragm and the upper surface of the liver. Their efferents open mainly into the thoracic duct. (8) The *intercostal lymph glands* are seen on the posterior thoracic wall in the posterior parts of the intercostal spaces and on the heads of the ribs. They receive lymph vessels from the posterior parts of the intercostal spaces. The efferents from the lower four or five spaces unite to form a trunk which descends and opens into the cisterna chyli or the commencement of the thoracic duct. The efferents from the upper spaces open into the thoracic duct on the left side and right lymphatic duct on the right side.

Dissection. Divide the trachea about an inch above its bifurcation and remove the lungs from the thoracic cavity. Trace the divisions of the bronchi and the pulmonary vessels in the substance of the lung. If one of the branches of the bronchus is traced inside the lung it will be seen to give off alternately *ventral* and *dorsal* branches. The former pass towards the anterior and the latter to the posterior border of the lung. These branches gradually diminish in their size and the cartilages, which are regularly arranged in the walls of the bronchi, become irregularly scattered in the walls of these branches and eventually disappear leaving a musculomembranous wall. Only one ventral branch of the hyparterial bronchus enters the middle lobe of the right lung.

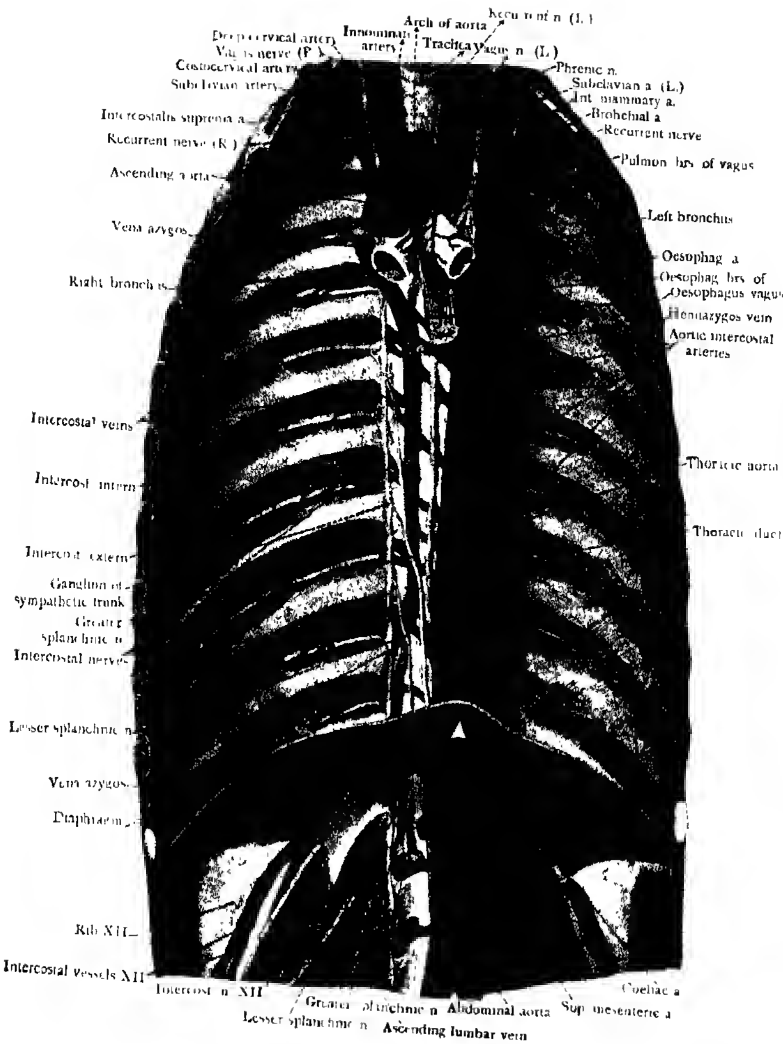

Fig. 65.—Dissection of the posterior mediastinum (Sobotta).

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The subdivisions of the pulmonary vessels accompany the ramifications of the bronchial tubes in the substance of the lung.

Sympathetic Nerve (Fig. 64).—The thoracic portion of the sympathetic nerve is usually composed of twelve ganglia linked together by intervening cords. Each ganglion is placed against the head of a rib except the last two which lie on the side of the bodies of the eleventh and twelfth thoracic vertebræ. Sometimes there are ten or eleven ganglia owing to the fusion of two ganglia into one. Each ganglion is connected with the corresponding thoracic spinal nerve by two branches called the rami communicantes. Of the two branches one is grey and the other white. The white ramus communicans comes from the spinal nerve to the sympathetic ganglion and the grey ramus communicans goes from the ganglion to the spinal nerve.

Branches.—(1) The *aortic branches* are minute filaments which pass from the upper five ganglia to the wall of the aorta. (2) The *pulmonary branches* pass from the third and fourth ganglia and enter the posterior pulmonary plexus. (3) The *greater splanchnic nerve* is formed by branches from the fifth or sixth to the ninth thoracic ganglia. These branches descend obliquely medialwards by the side of the bodies of the thoracic vertebræ and unite to form the trunk of this nerve which pierces the crus of the diaphragm and ends in the upper part of the cœliac ganglion. Often a ganglion called the *splanchnic ganglion* is developed on the nerve before it pierces the diaphragm. (4) The *lesser splanchnic nerve* is usually formed by two branches from the tenth and eleventh thoracic ganglia. It pierces the crus of the diaphragm and ends in the aorticorenal ganglion. (5) The *lowest splanchnic nerve* arises from the twelfth thoracic ganglion, perforates the crus of the diaphragm and terminates in the renal plexus.

The **Hemiazygos Vein** (Vena azygos minor inferior) begins in the abdomen as the left ascending lumbar vein. It enters the thorax through the left crus of the diaphragm and ascends to the level of the eighth thoracic vertebra along the left side of the vertebral column, crossing the left intercostal arteries in its course. Then it crosses the vertebral column from the left to the right behind the descending aorta, the thoracic duct and the œsophagus and opens into the azygos vein. Its tributaries are the left subcostal vein, the lower three or four left intercostal veins and sometimes the accessory hemiazygos vein.

The **Accessory Hemiazygos Vein** (Vena azygos minor superior)

is formed usually by the veins from the fourth to the eighth intercostal spaces of the left side. It descends along the left side of the vertebral column and at the level of the seventh thoracic vertebra crosses to the right to open into the azygos vein or sometimes into the hemiazygos vein.

THE POSTERIOR THORACIC WALL

The dissector should now examine the posterior part of the thoracic wall from within.

The *posterior intercostal membrane* is the continuation medialwards of the internal intercostal muscle from the angle of the rib laterally to the anterior costo-transverse ligament medially. It covers the deep surface of the external intercostal muscle.

The *subcostales* are muscular slips placed on the inner surfaces of the ribs near their angles. The direction of their fibres is like that of the internal intercostal muscles. They arise from the inner surface of one rib and are inserted into the inner surface of the rib below or may pass over two or three intercostal spaces before insertion. The subcostales depress the ribs and are supplied by intercostal nerves.

The student should note that the external intercostal muscle lies behind the posterior intercostal membrane and extends medially up to the tubercle of a rib.

Intercostal Arteries (Fig. 65).—There are eleven pairs of intercostal arteries. In the first two intercostal spaces they are derived from the arteria intercostalis suprema which springs from the costocervical branch of the subclavian artery; while in the nine lower intercostal spaces they (the nine pairs of aortic intercostal arteries) are derived from the back of the thoracic aorta. In consequence of the thoracic aorta lying to the left of the median line of the vertebral column the right aortic intercostal arteries are longer than the left. The *right aortic intercostals* cross the bodies of the thoracic vertebræ behind the œsophagus, the thoracic duct and the azygos vein and lie under cover of the parietal pleura. The *left aortic intercostal arteries* pass backwards on the sides of the thoracic vertebræ and lie under cover of the pleura. From the sides of the bodies of the thoracic vertebræ the further course of the intercostal arteries on both sides is almost the same. They pass lateralwards behind the parietal pleura and the sympathetic nerve trunk and enter the intercostal spaces.

Here each artery at first lies on the posterior intercostal membrane covered by the parietal pleura and then between the internal and external intercostal muscles in the costal groove. In the costal groove the companion vein lies above and the intercostal nerve lies below. Its further course has been described (p. 143). Each intercostal artery gives off a *posterior branch* as it enters the intercostal space which passes backwards medial to the anterior costo-transverse ligament and opposite the intervertebral foramen gives off a *spinal branch* which enters the vertebral canal to supply the medulla spinalis and its membranes. The posterior branch then divides into a medial and a lateral branch which pass in company with the corresponding branches of the posterior division of a thoracic spinal nerve.

The **Subcostal Arteries** are two in number, one on each side. They are in a line with the intercostal arteries and arise from the back part of the thoracic aorta. They pass lateralwards below the twelfth rib accompanied by the twelfth thoracic nerve and enter the abdominal wall beneath the lateral lumbocostal arch. Their further course has been described (p. 30).

The **Arteria Intercostalis Suprema** is a branch of the costo-cervical artery. It descends in front of the neck of the first rib and opposite the first intercostal space divides into the first and second intercostal arteries. The *first intercostal artery* runs along the first intercostal space and the *second intercostal artery* descends in front of the neck of the second rib to the second intercostal space along which it runs. Their course and distribution are like those of the upper aortic intercostal arteries.

Thoracic Nerves.—The anterior divisions of the thoracic nerves are twelve in number on each side; eleven of them are known as *intercostal nerves*, the twelfth is placed below the last rib. They differ from the other spinal nerves in not joining with one another to form a plexus. Their connections with the ganglia of the sympathetic trunk by the white and grey rami communicantes have been described (p. 96). The greater portion of the anterior division of the *first thoracic nerve* ascends in front of the neck of the first rib to join the brachial plexus. The smaller portion of it is continued in the intercostal space like the other intercostal nerves but it gives off no lateral cutaneous branch. The anterior division of the *second thoracic nerve* sometimes sends a communicating filament upwards along the neck of the second rib to join the portion of the first nerve which goes to the brachial plexus. The anterior divisions of the *third* to the *eleventh* (inclu-

sive) *thoracic nerves* lie at first on the posterior intercostal membrane covered by parietal pleura. Near the angles of the ribs they pass between the internal and external intercostal muscles. Their further course and distribution have been noted (p. 141). The anterior division of the *twelfth thoracic nerve* accompanies the subcostal artery and its course and distribution have been examined (p. 100).

The **Intercostal Veins** also called the *posterior intercostal veins* are eleven in number on each side. There is a single vein in each space which is placed above the corresponding artery in the costal groove. On the *right side* the first intercostal vein, called the highest intercostal vein, terminates usually in the right innominate vein. The second and third intercostal veins unite to form the *right superior intercostal vein* which opens into the azygos vein. The remaining right intercostal veins open separately into the azygos vein. On the *left side* the highest intercostal vein opens usually into the left innominate vein. The *left superior intercostal vein* formed by the union of the second and third intercostal veins opens into the left innominate vein. The fourth, fifth, sixth, seventh and eighth intercostal veins usually end in the accessory hemiazygos vein. The ninth, tenth, and eleventh intercostal veins usually open into the hemiazygos vein.

The *subcostal vein* of the right side opens into the azygos vein and that of the left side into the hemiazygos vein.

ARTICULATIONS OF THE THORAX

1. **Sterno-costal Joints.**—The cartilages of the upper seven ribs articulate with the sternum. The joint between the first costal cartilage and the manubrium sterni is a synchondrosis and there is no synovial cavity between the cartilage and the sternum. The remaining six sterno-costal joints are arthrodial joints and the ligaments connecting the articular surfaces are :—(1) The *radiate sternocostal ligaments* are strong bands which radiate from the anterior and posterior surfaces of the sternal ends of the costal cartilages. On the sternum they blend with the periosteum. (2) The *interarticular sternocostal ligaments* pass from the extremities of the costal cartilages to the side of the sternum. These ligaments subdivide the joint cavities into upper and lower compartments, each of which is lined by a separate synovial stratum. This ligament is always present in

the joint between the second costal cartilage and the sternum and in the lower ones it is usually absent. Where it is absent there may be one synovial cavity or none at all. (3) The *articular capsules* surround these joints from the second to the seventh. *Movements.*—The sternocostal articulations permit very limited amount of gliding movements.

II. **Interchondral Joints.**—These are diarthrodial joints between the contiguous margins of the sixth, seventh, eighth, ninth and tenth costal cartilages. Each joint is enclosed by an articular capsule lined by a synovial stratum.

III. **Intersternal Joints.**—These are two in number, one between the manubrium sterni and the body of the sternum and the other between the body of the sternum and the xiphoid process. The former is a symphysis ; the lower margin of the manubrium and the upper margin of the body of the sternum being coated with cartilage and joined to each other by a piece of fibrocartilage. The joint is strengthened in front and behind by longitudinal fibres. The joint between the body of the sternum and the xiphoid process is a synchondrosis ; the cartilage intervening between the segments ossifies after middle age.

IV. **Costovertebral Joints.**—These include two sets of articulations : (*a*) Articulations of the heads of the ribs (capitular articulations) and (*b*) Articulations of the necks and tubercles of the ribs (costo-transverse articulations).

(*a*) **Capitular Articulations** (arthrodia).—The head of a rib articulates with the cavity formed by the costal facets on the sides of two contiguous vertebræ and the intervertebral fibrocartilage between them. The first, tenth, eleventh and twelfth ribs articulate with single facets on the vertebræ of the same number. The following ligaments are seen in these joints :— (1) The *articular capsules* connect the head of the rib to the articular cavity formed by two contiguous vertebræ and the intervening fibro-cartilage. Two articular capsules are seen in the joints from the second to the ninth ribs inclusive, in as much as an interarticular ligament divides each of these joints into two. In the case of the first, tenth, eleventh and twelfth ribs the capsule is not divided into two. (2) The *interarticular ligament* connects the interarticular ridge on the head of a rib with the intervetebral fibrocartilage. It subdivides the joint cavity into two, an upper and a lower, which are lined by separate synovial strata. This ligament is absent in the first tenth, eleventh and twelfth ribs and hence there is only one synovial

stratum lining the capsule. (3) The *radiate ligament* (stellate ligament) extends from the anterior surface of the head of each rib to the sides of the vertebræ above and below and to the intervening fibrocartilage in a radiating manner. *Movements.*—The capitular articulations permit slight gliding movements.

(*b*) **Costo-transverse Articulations.**—The articular portion of the tubercle of a rib forms with the articular area on the transverse process of the corresponding vertebra an arthrodial joint. This articulation is absent in the eleventh and twelfth ribs. The following ligaments are seen in the joint :—(1) The *articular capsule* surrounds the articular facet on the tubercle of a rib and on the anterior surface of the tip of a transverse process. It is lined by a synovial stratum.

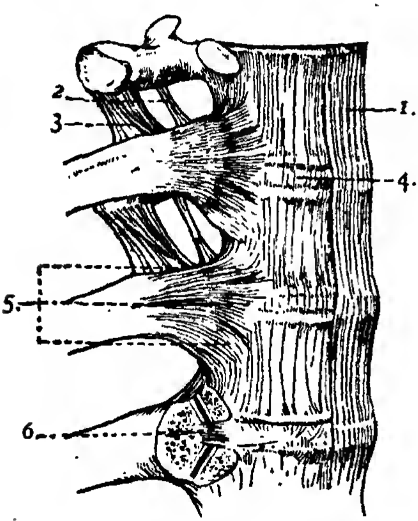


Fig. 66.—Ligaments of the costovertebral and costotransverse joints.

1. Anterior longitudinal ligament.
2. Posterior costo-transverse ligament.
3. Anterior costo-transverse ligament.
4. Intervertebral fibrocartilage.
5. Radiate ligament.
6. Interarticular ligament.

(2) The *ligament of the tubercle of the rib* (posterior costo-transverse ligament) is a thickening on the posterior part of the capsule extending from the tip of the transverse process to the rough portion of the tubercle of the rib. (3) The *anterior costo-transverse ligament* extends from the upper border of the neck of the rib to the lower border of the transverse process of the vertebra above. (4) The *posterior costotransverse ligament* extends from the neck of the rib behind the attachment of the anterior costotransverse ligament to the base of the transverse process and the adjoining part of the inferior articular process of the vertebra above. (5) The *ligament of the neck of the rib* (middle costotransverse ligament) binds the posterior surface

of the neck of a rib to the anterior surface of the transverse process against which it lies. *Movements.*—The costo-transverse articulations permit slight gliding movements.

V. The **Intervertebral Joints** comprise (*a*) the articulations between the bodies of the vertebræ and (*b*) the articulations between the vertebral arches.

The articulations between the bodies of the vertebræ constitute amphiarthrodial joints (symphysis). The ligaments connecting them are :—(1) The *anterior longitudinal ligament* (anterior common ligament) extends along the front of the bodies of the vertebræ. It is broader below than above and is firmly attached to the anterior surfaces of the bodies of the vertebræ and to the intervertebral fibrocartilages. It is narrow opposite the central parts of the bodies. Its superficial fibres are long and deep fibres short. (2) The *posterior longitudinal ligament* (posterior common ligament) extends along the posterior surfaces of the bodies of the vertebræ. It is broad where it is attached to the intervertebral fibrocartilage and to the contiguous margins of the bodies of the vertebræ. It is narrow opposite the central parts of the bodies from which it is separated by the basivertebral veins. (3) The *intervertebral fibrocartilages* are discs of white fibrocartilage placed between the contiguous surfaces of the bodies of the vertebræ. In the thoracic region they are almost of uniform thickness; in the cervical and lumbar regions they are thicker in front than behind. Their peripheral portions are fibrous and the central portions are soft and pulpy. Laterally they are attached to the interarticular ligaments of the costo-vertebral articulations. (4) The *intertransverse ligaments* extend between the tips of the transverse processes. (5) The *articular capsules* are attached to the margins of the articular processes of adjacent vertebræ. They are usually thin and loose. (6, 7, 8) The ligamenta flava, connecting the laminæ and the interspinal and supraspinal ligaments connecting the spinous processes will be studied during the dissection of the back.

TABLE OF THE ARTERIES OF THE THORAX

Aorta consists of

- A. Ascending Aorta ..
  - Right coronary
    - Marginal
    - Posterior descending
  - Left coronary
    - Anterior descending
    - Circumflex
- B. Arch of Aorta
  - 1. Innominate
    - a. Right common carotid .. See Table of Head and Neck
    - b. Right subclavian
      - 1. Vertebral .. See Table of Head and Neck
      - 2. Internal mammary
        - 1. Pericardiacophrenic.
        - 2. Mediastinal
        - 3. Pericardial
        - 4. Sternal
        - 5. Anterior intercostal
        - 6. Perforating
        - 7. Musculo-phrenic
          - Muscular
          - Anterior intercostal
        - 8. Superior epigastric.
      - 3. Thyreocervical .. See Table of Head Neck.
      - 4. Costocervical
        - a. Arteria intercostalis suprema
          - 1st intercostal artery
          - 2nd intercostal artery
        - b. Arteria cervicalis profunda
    - c. Thyreoidea ima (occasional)
  - 2. Left common carotid
  - 3. Left subclavian
- C. Descending Aorta consists of
  - A. Thoracic Aorta.
    - 1. Intercostal ..
      - a. Posterior ..
        - Spinal
        - Medial
        - Lateral
      - b. Collateral
      - c. Muscular
      - d. Lateral cutaneous
    - 2. Subcostal
    - 3. Bronchial
    - 4. Pericardiac
    - 5. Oesophageal
    - 6. Posterior mediastinal
    - 7. Superior phrenic
  - B. Abdominal Aorta .. See Table of Abdomen

Pulmonary Artery ..

- 1. Right pulmonary.
- 2. Left pulmonary.

TABLE OF THE VEINS OF THE THORAX

SUPERIOR VENA CAVA receives

- 1. Azygos .. receives ..
  - a. Right subcostal
  - b. Right posterior intercostal veins (except first)
  - c. Hemiazygos .. receives ..
    - a. Left subcostal
    - b. Left lower three posterior intercostal
    - c. Oesophageal
    - d. Mediastinal
  - d. Accessory hemiazygos .. receives .
    - a. 4th to 8th left posterior intercostal.
    - b. Left bronchial
  - e. Oesophageal .
  - f. Mediastinal ..
  - g. Pericardial ..
  - h. Right bronchial
- 2. Pericardiac
- 3. Mediastinal
- 4. RIGHT INNOMINATE .. receives..
  - 1. Right vertebral 2. Right internal mammary
  - 3. Right inferior thyreoid 4. Right first intercostal
- 5. LEFT INNOMINATE .. receives ..
  - 1. Left vertebral 2. Left internal mammary 3. Left inferior thyreoid 4. Left first intercostal. Left superior intercostal 6. Pericardiac 7. Thymic

RIGHT PULMONARY (two) .. .. end in Left Atrium

LEFT PULMONARY (two) .. .. end in Left Atrium

VEINS OF THE HEART

- 1. Coronary sinus opens into right atrium .. receives
  - a. Great cardiac vein
  - b. Small cardiac vein
  - c. Middle cardiac vein
  - d. Posterior cardiac vein
  - e. Oblique vein of left atrium
- 2. Anterior cardiac veins open into right atrium
- 3. Venae cordis minimae open into all cavities of heart

TABLE OF THE NERVES OF THE THORAX

Vagus nerve ..
1. *Inferior cardiac* .. end in deep cardiac plexus
2. Left recurrent .. from the left vagus
3. Anterior bronchial .. form anterior pulmonary plexus
4. Posterior bronchial .. form posterior pulmonary plexus
5. Oesophageal .. form oesophageal plexus

Phrenic nerve .. to pericardium, pleura and diaphragm

Intercostal nerve
- *a.* Ends in Anterior cutaneous nerve
- *b.* Gives off
  1. Muscular
  2. Lateral cutaneous .. Anterior; Posterior

Thoracic portion of sympathetic nerve consists of
- A. Twelve ganglia ..
  - *a.* Connected with thoracic spinal nerves by white and grey rami communicantes
  - *b.* Give off
    1. Aortic from upper five ganglia
    2. Pulmonary from 2nd, 3rd, 4th end in posterior pulmonary plexus
    3. Greater splanchnic from 5th to 9th
    4. Lesser splanchnic from 10th and 11th
    5. Lowest splanchnic from 12th
- B. Intervening portions of the trunk

HEAD AND NECK

When the subject is brought into the dissecting-room it is placed in the lithotomy position. The dissector of the head and neck starts work at once. The work assigned to him on the first, second and third days is the dissection of the scalp and the temporal region.

THE SCALP AND THE TEMPORAL REGION

Surface Anatomy.—Before beginning to reflect the skin *the following landmarks should be felt and recognised on the* cranium :– the glabella, the superciliary arch, the supraorbital margin, the zygomatic process of the frontal bone, the parietal tuberosity, the superior temporal line, the zygomatic arch, the mastoid process and the external occipital protuberance.

Dissection. The head should be shaved and raised on a block. Make an incision from the root of the nose backwards along the middle line to the external occipital protuberance. Another incision is to be made from the tip of the mastoid process of one side vertically upwards ; it should then pass along the vertex of the skull across the line of the first incision and ultimately be carried downwards to the tip of the mastoid process of the opposite side. A third incision is to be made on each side by carrying the knife from the tip of the mastoid process in an arched manner over the pinna of the ear to the posterior root of the zygomatic process. The two flaps of the skin in front are to be reflected to the level of the supraorbital margins in front and the zygomatic arches laterally. The remaining two flaps of the skin behind are to be reflected to the level of a line joining the external occipital protuberance to the tip of the mastoid process.

The term "scalp" includes the soft structures covering the skull between the supraorbital margins in front, the superior temporal lines at the sides and the superior nuchal lines behind. The "temporal region" includes the portion of the head lying

between the superior temporal line and the zygomatic arch.

There are *five layers* in the scalp in the following order from without inwards.

1. The skin
2. The superficial fascia.
3. The epicranius with its aponeurosis.
4. The subaponeurotic areolar tissue.
5. The pericranium.

There are *eight layers* of soft structures in the temporal region in the following order from without inwards.

1. The skin.
2. The superficial fascia.
3. The extrinsic muscles of the ear.
4. The thin lateral portion of the aponeurosis of the epicranius.
5. A thin layer of fascia which descends from the superior temporal line to the pinna.
6. The temporal fascia.
7. The temporal muscle.
8. The pericranium.

The **skin** of the scalp is firmly attached to the epicranius by the fibrous processes of the superficial fascia ; hence the difficulty in separating the skin from the superficial fascia and the mobility of the hairy scalp during the contraction of the epicranius.

The **Superficial Fascia** is a firm dense layer of fibrous tissue containing numerous lobules of fat. It is firmly attached to the overlying skin and to the epicranius lying underneath.

Dissection. Remove the superficial fascia taking care that the cutaneous nerves and blood-vessels which ramify in it are not injured. Look for—the supraorbital vessels and nerve near the supraorbital notch ; the frontal artery and the supratrochlear nerve at the medial angle of the orbit ; the superficial temporal artery and the auriculo-temporal nerve just in front of the ear ; the temporal branches of the facial nerve as they pass upwards crossing the zygomatic arch ; the branch of the zygomatic nerve above the front part of that arch ; the posterior auricular artery and nerve just behind the ear ; the occipital artery and the occipital nerves at the back of the head.

Vessels. (Fig. 67).—Five arteries, on each side, ramify over the scalp and anastomose with one another freely. (1) The *frontal artery*

is one of the terminal branches of the ophthalmic artery. It emerges from the orbit at its medial angle accompanied by the supratrochlear nerve. It supplies the skin and muscles over the front part of the forehead. (2) The *supraorbital artery* is derived from the ophthalmic artery. It emerges from the orbit through the supraorbital foramen accompanied by the supraorbital nerve. It supplies the skin and muscles of the forehead and anastomoses with the frontal artery and with the frontal branch of the superficial temporal artery. The *frontal* and *supraorbital veins* meet at the medial angle of the orbit to form the *angular vein*. (3) The *superficial temporal artery* is one of the terminal branches of the external carotid. It appears in the temporal region by crossing the posterior part of the zygomatic arch just in front of the ear in company with the auriculo-temporal nerve. It divides into an anterior or frontal and a posterior or parietal branch. The *frontal branch* passes upwards and forwards supplying the muscles and skin and anastomoses with the supraorbital and frontal arteries. The *parietal branch* curves upwards and backwards along the side of the head and anastomoses with the posterior auricular and occipital arteries and with its fellow of the opposite side. The *superficial temporal vein* begins on the side and vertex of the skull. It unites with the middle temporal vein to form the posterior facial vein which cannot be seen now. (4) The *posterior auricular artery* is a branch of the external carotid. In the scalp it appears between the mastoid process and the ear and divides into an anterior or auricular branch and a posterior or occipital branch. The *auricular branch* passes upwards beneath the auricularis posterior, supplies the back part of the auricula and anastomoses with the parietal branch of the superficial temporal artery. The *occipital branch* runs backwards and anastomoses with the occipital artery. The *posterior auricular vein* begins on the side of the head and its termination in the external jugular vein cannot be seen now. (5) The *terminal part of the occipital artery* is seen lateral to the external occipital protuberance and is accompanied by the greater occipital nerve. It passes upwards taking a tortuous course and supplies the soft parts over the upper and back portions of the cranium. The *occipital vein* begins at the posterior part of the skull and its termination in the deep cervical and vertebral veins cannot be seen now.

Lymphatic vessels of the Scalp. The lymphatic vessels from the frontal, temporal and anterior parietal regions of the

scalp drain into the anterior auricular and parotid lymph glands in front of the ear. Those from the posterior parietal region drain into the posterior auricular lymph glands behind the ear. The lymphatic vessels from the occipital origin of the scalp drain into the occipital lymph glands.

Nerves. (Fig. 67).—The portion of the scalp in front of the ear is supplied by branches from the trigeminal nerve which is sensory and by branches from the facial nerve which is motor. The portion of the scalp behind the ear is supplied by branches from the cervical nerves which are sensory and by the posterior auricular branch of the facial nerve which is motor. (1) The supratrochlear nerve is the medial terminal branch of the frontal nerve. It emerges from the orbit at its medial angle and ascends beneath the corrugator and frontalis muscles. It then pierces the frontalis muscle and supplies the skin of the forehead near the middle line. (2) The *supraorbital nerve* is the lateral terminal branch of the frontal nerve. It emerges from the orbit through the supraorbital notch or foramen and ascends beneath the orbicularis oculi and frontalis muscles. It then divides into two branches, a medial and a lateral The medial branch pierces the frontalis muscle; the lateral branch pierces the galea aponeurotica; both branches supply the skin over the parietal bone. (3) The *temporal branches of the facial nerve* appear in the temporal region by crossing the zygomatic arch. They supply the corrugator, the orbicularis oculi, the frontalis and the auriculares anterior and superior muscles. (4) The *zygomatico-temporal branch of the zygomatic nerve* pierces the temporal fascia about an inch above the front part of the zygomatic arch. It supplies the skin of the temporal region. (5) The *auriculo temporal nerve* is a branch of the mandibular nerve. Its terminal portion appears in the temporal region by crossing the zygomatic arch just in front of the ear in company with the superficial temporal artery. It divides into an anterior and a posterior branch which supply the skin of the scalp and the temporal region. (6) The *posterior auricular nerve* is a branch of the facial nerve. It ascends with the posterior auricular artery in the interval between the mastoid process and the ear and divides into an anterior or auricular branch and a posterior or occipital branch. The auricular branch supplies the auricularis posterior. The occipital branch passes backwards and supplies the occipitalis. (7) The *posterior branch of the greater auricular nerve* ascends close to the preceding nerve and supplies the skin over the mastoid process and

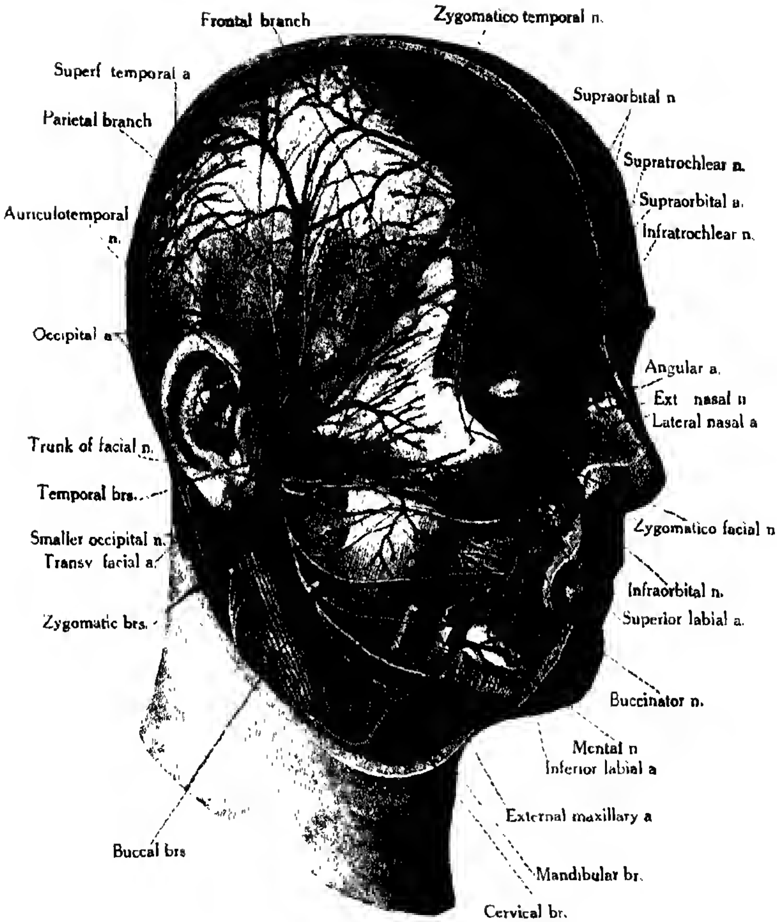


Fig. 67.—Arteries and nerves of the scalp and face (Sobotta).

To face P. 200.

the back of the ear. (8) The *smaller occipital nerve* is derived from the anterior primary division of the second cervical or sometimes also from the third cervical nerve. It ascends behind the mastoid process and supplies the skin of the occipital and mastoid regions. It gives off an auricular branch which supplies the skin of the upper part of the cranial surface of the auricula. It communicates with the greater auricular, the posterior auricular and greater occipital nerves. (9) The *greater occipital nerve* is the medial branch of the posterior division of the second cervical nerve. It lies close to the occipital artery and divides into many branches which supply the skin over the back part of the head as far forwards as the vertex. Sometimes it gives off an auricular branch which supplies the skin over the back part of the ear. (10) The *third occipital nerve* is the medial branch of the posterior division of the third cervical nerve. It lies medial to the greater occipital nerve and supplies the skin of the lower part of the back of the head.

Dissection. Remove the vessels and nerves of the scalp and clean the fibres of the epicranius.

The **Epicranius** (Occipito-frontalis) is placed symmetrically one on each side of the cranial vault and consists of an anterior muscular portion called the frontalis, a posterior muscular portion called the occipitalis, and an intermediate aponeurotic portion called the galea aponeurotica.

The **Frontalis** has no bony attachments ; it is attached to the superficial fascia over the eyebrow and the root of the nose. Here its fibres are blended with those of the orbicularis oculi laterally and the corrugator and procerus medially. The fibres pass upwards and end in the galea aponeurotica near the coronal suture. Medially the muscle fibres of the two sides are continuous. *Action.*—It raises the eyebrow and wrinkles transversely the skin of the forehead ; continuing to act it draws the scalp forwards. It is supplied by the temporal branches of the facial nerve.

The **Occipitalis** arises (1) from the lateral two thirds of the superior nuchal line of the occipital bone and (2) from the adjacent mastoid portion of the temporal bone. The fibres pass upwards and end in the galea aponeurotica. Medially the muscles of the two sides are separated from each other by an interval occupied by a prolongation of the galea. *Action.*—It moves the scalp backwards. If both the frontales and the occipitales act alternately the whole scalp moves forwards and backwards. The

occipitalis is supplied by the posterior auricular branch of the facial nerve.

The **Galea Aponeurotica** (Epicranial aponeurosis) connects the frontalis with the occipitalis. Behind it is prolonged between the two occipitales muscles and is attached to the external occipital protuberance and the highest nuchal lines of the occipital bone. In front it is prolonged as a pointed process filling up the V-shaped gap between the upper parts of the frontales muscles. On either side a thin fascia is prolonged from its lateral margin to the zygomatic arch and gives origin to the anterior and superior auriculares.

Dissection. Make a short crucial incision in the galea aponeurotica over the vertex of the skull and raise the corners of the flaps. This will reveal the layer of subaponeurotic areolar tissue.

The *subaponeurotic areolar tissue* connects loosely the galea aponeurotica to the pericranium. But it is intimately adherent to the galea over the supraorbital ridges and temporal regions; posteriorly it is absent at the site of the bony attachments of the galea and the occipitales.

The *pericranium* is the periosteum covering the cranium which lies underneath the areolar tissue. Make an incision in the pericranium and reflect it from the surface of the bone for some distance. Observe that it is firmly attached to the cranial sutures, but it can be easily separated from the surface of these bones beyond the sutures.

Dissection. In the temporal region three *extrinsic muscles of the ear*, viz., the auricularis anterior, the auricularis superior and the auricularis posterior which lie beneath the superficial fascia are to be cleaned. Draw the ear backwards and fix it with hooks—this will make the fibres of the auricularis anterior prominent: similarly the auricularis superior can be made prominent by hooking the ear downwards and the auricularis posterior by hooking the ear forwards.

The *auricularis anterior* (attrahens aurem) lies in front of the auricula. It is a small fan-shaped muscle which arises by its base from the lateral margin of the galea aponeurotica and is inserted by its apex into the spina helicis.

The *auricularis superior* (attolens aurem) is also fan-shaped but is a larger muscle and is situated above the auricula. It arises by its broad base from the lateral margin of the galea aponeurotica and is inserted by its apex into the upper part of the cranial surface of the pinna.

The *auricularis posterior* (retrahens aurem) is situated behind the auricula and consists of two or three separate fasciculi. It arises from the mastoid portion of the temporal bone and is inserted into the cranial surface of the concha at its lower part.

Nerve-supply.—The auriculares anterior and superior are supplied by the temporal branches of the facial nerve. The auricularis posterior is supplied by the posterior auricular branch of the same nerve. *Actions.*—The three muscles move slightly the auricula in the following manner: the anterior, forwards and upwards; the superior, upwards; the posterior, backwards.

Dissection. The remaining layers in the temporal region may now be examined. Reflect the lateral prolongation of the galea aponeurotica together with the superior and anterior auricular muscles towards the zygomatic arch. A *layer of thin fascia* is now seen beneath it passing from the superior temporal line to the pinna. This is the fifth layer in the temporal region. Reflect this fascia downwards from the superior temporal line. The *temporal fascia* attached to the superior temporal line is now exposed. This is the sixth layer in the temporal region. Detach the temporal fascia from the superior temporal line and reflect it downwards. While reflecting it note that the temporal muscle takes origin from the deep surface of the fascia. The origin of the *temporalis muscle* is exposed. This is the seventh layer in the temporal region. Detach the temporal muscle from its origin from the temporal fossa and reflect it downwards over the zygomatic arch. The *pericranium* which forms the eighth layer is now exposed.

REMOVAL OF THE BRAIN. THE DURA MATER, ITS PROCESSES AND SINUSES. THE EXIT OF THE CEREBRAL NERVES. THE ARTERIES ENTERING INTO THE CRANIAL CAVITY. THE CRANIAL FOSSÆ.

Dissection. The skull cap is now to be sawn through. The saw line which encircles the whole of the skull is marked with the knife by cutting the scalp down to the bone. In front, this line is about three-fourths of an inch above the supraorbital margins. Behind, the line is about half an inch above the level of the external occipital protuberance. The ends of the lines in front and behind are to be joined together by carrying the edge of the knife along the lateral aspect of the skull on each side. Divide the outer table of the skull by the saw. When the diploe

is reached (which will be indicated by lessened resistance) the saw *is no longer to be used. The inner table is then broken* by the chisel and hammer. In this way any injury to the membranes or brain substance is avoided. When the skull cap has become loose, the hook of the end of chisel is to be introduced into the cut in front. Next the skull cap is to be pulled off backwards and forcibly detached. The external surface of the dura mater is now brought into view.

The **Dura Mater** is the outermost covering of the brain which is enveloped by three membranes called the *meninges*. The innermost covering is called the *pia mater*; while between the dura mater and the pia mater is the intermediate covering called the *arachnoid*. The outer surface of the dura mater is rough and firmly adherent to the inner surfaces of the skull bones specially along the lines of the sutures—this has been noticed during the removal of the skull cap. Small granular masses, called the *arachnoideal granulations* are seen on either side of the middle line of the dura mater specially if the subject is old. Indentations on the inner surface of the skull cap on either side of the sagittal suture are seen corresponding to these outgrowths. These granulations are the outgrowths of the arachnoideal trabeculæ which have pushed and stretched the dura mater before them. If the outer surface of the dura mater is well sponged the ramifications of the middle meningeal artery on either side will be seen. On the inner surface of the skull cap that has been removed grooves corresponding to these branches of the artery are seen.

Dissection. Pinch the dura mater with forceps and with a pair of scissors cut it antero-posteriorly on either side about half an inch lateral to the middle line. Make a vertical incision in each lateral flap from the centre of the first incision. Reflect the four flaps of dura mater thus formed over the sawn margin of the skull. The inner surface of the dura mater is now seen.

Layers of the dura mater.—The inner surface of the dura mater is smooth and free and is separated from the arachnoid by an interval called the *subdural space*. This space contains a little serous fluid enough to lubricate the opposed surfaces of the two membranes. The dura mater consists in reality of two layers an outer or *endosteal layer* which lines the inner surfaces of the cranial bones serving as an internal periosteum; and an inner or *meningeal layer* which protects the brain giving off processes between the different parts of the brain for their support.

These two layers are intimately blended together except in some places where they separate and form venous channels called *sinuses*.

Dissection. The superior sagittal sinus is now to be opened. It is contained in the central strip of dura mater which has been left in the middle line. Lay open the sinus by incising its exposed upper wall from behind forwards

The **Superior Sagittal Sinus** (Superior longitudinal sinus) is a venous channel situated along the convex margin of the falx cerebri. It extends from the foramen cæcum in front to the internal occipital protuberance behind, grooving the inner surfaces of the cranial bones along the middle line of the vertex of the skull. The lumen of the sinus is triangular, small in front and gradually increases in size as it is traced backwards. Slender fibrous bands traverse the sinus at its inferior angle. These bands are called *chordæ Willisii.* On either side of the sinus are seen recesses, called *venous lacunæ*, which exist between the two layers of the dura mater and open into the sinus ; many cerebral veins open into these lacunæ. The arachnoidean granulations project into the sinus and lacunæ. Emissary veins establish a communication between the sinuses of the dura mater and the veins outside the cranial cavity. In connection with the superior sagittal sinus an *emissary vein* passes through the foramen cæcum connecting the front part of the sinus with the veins of the nasal fossæ. Two other emissary veins pass through the parietal foramina and connect the sagittal sinus with the occipital veins in the scalp. The superior cerebral veins are the tributaries of the superior sagittal sinus. The superior sagittal sinus terminates usually in the right lateral sinus.

Dissection. Pull the hemispheres of the cerebrum a little away from each other and note that the superior cerebral veins are passing medialwards along the surface of the hemispheres towards the lateral wall of the superior sagittal sinus. Those veins which terminate at the back part of the sinus do not however open into it as soon as they reach its lateral wall but turn forwards lying against it and then open obliquely into the sinus. If a bristle is passed into one of these openings in the sinus it will point obliquely forwards and medialwards. This shows that the blood from these veins flows forwards into the sinus. The main current of blood in the sinus however flows from before backwards. Those superior cerebral veins which terminate

at the front part of the sinus open into it at right angles. Divide these cerebral veins and observe the process of the dura mater which sinks between the hemispheres antero-posteriorly. This is the falx cerebri.

The **Falx Cerebri** is a sickle-shaped process of the dura mater formed by the reduplication of its inner meningeal layer. It dips in vertically between the cerebral hemispheres. In front it is attached to the crista galli of the ethmoid by its narrow extremity. Behind it is broad and is attached to the upper surface of the tentorium cerebelli where it splits and forms with the tentorium a venous passage called the straight sinus. Its upper margin is convex and attached to the middle line of the vertex of the skull as far back as the internal occipital protuberance; it splits to enclose the superior sagittal sinus. Its lower margin is concave and free and contains the inferior sagittal sinus.

Removal of the Brain.—The student should now proceed to remove the brain. Divide the falx cerebri at its attachment to the crista galli and throw it backwards. Tilt the head a little backwards and support the hind part of the brain with the hand,—this support should be continued till the whole brain is removed. The frontal lobes of the brain are then dislodged from the anterior fossa of the base of the skull as also the *olfactory bulbs* and *tracts* from the lamina cribrosa of the ethmoid with the handle of the scalpel. Next take a sharp scalpel and divide the cerebral nerves in succession from before backwards as they perforate the dura mater. In dividing the nerves cut them short on one side and long on the other. Divide the *optic nerves* which will be seen close to the anterior clinoid processes as they enter the optic foramina. The *internal carotid arteries* which also come into view are also to be divided. The *hypophysis* is next to be dislodged from the fossa hypophyseos with the *infundibulum* attached to it by incising the margin of the diaphragma sellæ (a process of the dura mater encircling the infundibulum). The thick *oculomotor nerves* which lie lateral to the internal carotid arteries are then divided. The free margin of the tentorium cerebelli close to its attachment to the clinoid processes is now seen. Lying under cover of this free margin are the slender *trochlear nerves* which should be divided. At this stage the tentorium cerebelli which is situated between the posterior part of the cerebrum and the cerebellum should be divided carefully by carrying the knife superficially along

its attached convex margin so that the cerebellum lying underneath may not be injured. The remaining cerebral nerves are now to be divided. The two roots of the *trigeminal nerve* pierce the dura mater close to the apex of the petrous portion of the temporal bone. The *abducent nerve* pierces the dura mater below the posterior clinoid process. The *facial* and *acoustic nerves* together with the *nervus intermedius* are to be divided where they enter the internal acoustic meatus. The *glosso-pharyngeal*, the *vagus* and the *accessory nerves* are to be divided just before they enter the jugular foramen. It should be noted that the accessory nerve is joined by filaments from the medulla spinalis. The *hypoglossal nerve* is to be divided where it pierces the dura mater in two separate bundles over the hypoglossal canal. Lastly divide the *medulla spinalis* as low down as possible together with the *vertebral arteries*. Then with two fingers of the right hand introduced through the foramen magnum dislodge the medulla oblongata and the cerebellum and take the whole brain out on to the left hand.

Preservation of the Brain.—The brain is next to be hardened. For this purpose a jar of sufficient capacity to contain the brain and preserving fluid and with a properly fitting lid is taken. At the bottom of the jar some tow is placed which serves as a cushion for the brain and preserves its normal contour. A ten per cent. solution of formalin is then poured into the jar sufficient to cover the brain and the padding of tow. Some punctures are made in the membranes covering the brain and then the organ is immersed in the lotion with its base uppermost. The mouth of the jar is then covered by the lid. For ordinary purposes the brain will be well hardened in formalin solution. But for special dissections the brain should be removed from the formalin solution after a week and transferred to another jar containing rectified spirit. The brain lies on a similar pad in this jar and should be kept in it till the dissection of the head and neck is finished, when the study of the brain is commenced.

Dura Mater.—The dura mater attached to the skull cap together with one of its processes, the falx cerebri, has been already examined. The portion of it attached to the base of the skull together with its remaining processes are now to be studied. It is most intimately attached to the bones at the base of the skull and around the foramen magnum. At the foramen magnum its inner layer becomes continuous with the dura mater of the medulla spinalis. It furnishes sheaths to the cerebral nerves

as they pass through the several foramina—its outer layer becomes continuous with the pericranium outside the foramina.

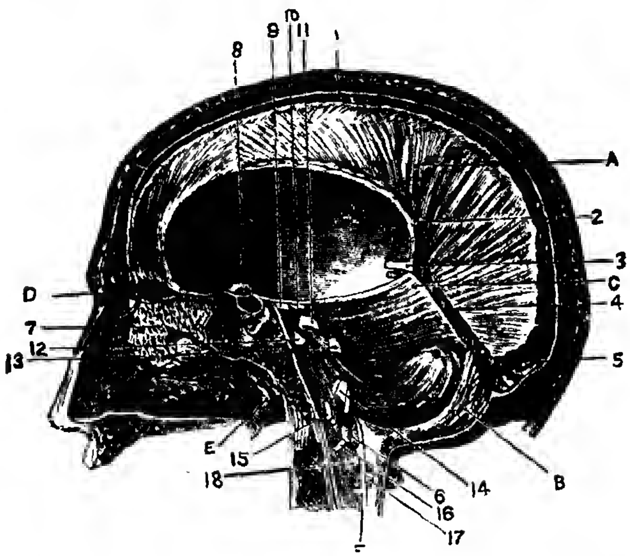


Fig. 68.—Processes and sinuses of the dura mater; exit of the cranial nerves;—sideview (from Hirschfeld and Leveille).

A. Falx cerebri.
B. Falx cerebelli.
C. Tentorium cerebri.
D. Crista galli of ethmoid.
E. Auditory tube.
F. Ligamentum denticulatum.
1. Superior sagittal sinus.
2. Inferior sagittal sinus.
3. Great cerebral vein.
4. Straight sinus.
5. Confluence of sinuses.
6. Vertebral artery.
7. Olfactory nerves.
8. Optic nerve.
9. Oculomotor nerve.
10. Trochlear nerve.
11. Trigeminal nerve.
12. Abducent nerve.
13. Facial and acoustic nerves.
14. Glossopharyngeal, vagus and accessory nerves.
15. Hypoglossal nerve.
16. First cervical nerve.
17. Posterior root of second cervical nerve.
18. Anterior root of second cervical nerve.

Processes of the Dura Mater.—The dura mater gives off four processes—two vertical viz., the falx cerebri and falx cerebelli; and two horizontal viz., the tentorium cerebelli and diaphragma sellæ. All of them are formed by reduplication of its meningeal layer.

The **Falx Cerebri** has been already examined.

The **Falx Cerebelli** is a triangular process of the dura mater given off between the hemispheres of the cerebellum. Its base is uppermost being attached to the inferior surface of the tentorium cerebelli at its back part. Its apex divides into two narrow processes which are continued to the sides of the foramen magnum. Its posterior border is convex and is attached to the internal occipital crest and encloses the occipital sinus. Its anterior border is free and lies in the cleft between the two cerebellar hemispheres.

The **Tentorium Cerebelli** is an arched process of the dura mater interposed between the cerebellum below and the posterior part of the cerebrum above. When observed in situ it is almost horizontal, elevated in the centre and gradually sloping down towards the circumferential attachment. Its posterior border or the circumferential attached part is convex and is attached behind to the margins of the transverse sulci on the inner surface of the occipital bone and to the margins of the groove at the inner aspect of the mastoid angle of the parietal bone; at this attachment it splits to enclose the transverse sinus; further in front it is attached to the superior border of the petrous portion of the temporal bone and here it splits to enclose the superior petrosal sinus. The anterior border is free and concave. At the apex of the petrous portion of the temporal bone the anterior and posterior borders meet and cross each other and are prolonged forwards to be attached respectively to the anterior and posterior clinoid process of the sphenoidal bone. Its superior surface is convex and gives attachment to the falx cerebri in the middle line antero-posteriorly; the straight sinus runs along the junction of these two processes of the dura mater. Its inferior surface gives attachment posteriorly to the base of the falx cerebelli.

The **Diaphragma Sellæ** is a circular horizontal fold which retains the hypophysis in the sella turcica. It presents a small opening in the centre through which the infundibulum passes.

The **Sinuses of the Dura Mater** may be arranged as follows :—

A. *Along the median plane.*	B. *Bilateral.*	C. *Accross the median plane.*
Superior sagittal.	Transverse.	Intercavernous.
Inferior sagittal.	Cavernous.	Basilar plexus.
Straight.	Sphenoparietal.	
Occipital.	Superior petrosal.	
	Inferior petrosal.	

The **Superior Sagittal Sinus** has been already examined.

The **Inferior Sagittal Sinus** (Inferior longitudinal sinus) lies enclosed in the free margin of the falx cerebri at its posterior half or two-thirds. It receives tributaries from the falx cerebri and a few veins from the medial surface of the cerebral hemispheres. It terminates behind at the anterior extremity of the straight sinus.

The **Straight Sinus** passes from before backwards along the tentorial border of the falx cerebri. At the internal occipital protuberance it terminates in one of the transverse sinuses (usually the left) which does not receive the superior sagittal sinus. Its tributaries are (1) the inferior sagittal sinus, (2) the great cerebral vein which opens at its front and (3) the superior cerebellar veins.

The **Transverse Sinuses** (Lateral sinuses) are two in number, a right and a left. The right one is usually a continuation of the superior sagittal sinus while the left one, of the straight sinus. Sometimes the superior sagittal sinus is continued into the left transverse sinus and the straight sinus into the right transverse sinus. At the beginning of the transverse sinus where the superior sagittal sinus opens there is a dilatation called the *confluence of sinuses.* Sometimes the two transverse sinuses at their commencement communicate with each other by a short transverse venous channel passing in front of the internal occipital protuberance. Each sinus passes lateralwards and forwards lying against the inner surface of the occipital bone and the mastoid angle of the parietal bone along the attached border of the tentorium cerebelli. It then curves downwards and medialwards lying along the sigmoid sulcus of the mastoid portion of the temporal bone; this part is known as the *sigmoid sinus.* Finally it passes through the posterior compartment of the jugular foramen to become continuous with the internal jugular vein. Its tributaries are (1) some cerebellar veins, (2) a diploic vein and (3) the superior petrosal sinus. It communicates with the extra-cranial veins by two emissary veins, one of which passes through the mastoid foramen and the other through the condyloid canal. The former establishes communication with the posterior auricular veins and the latter with the deep venous plexuses in the suboccipital region.

The **Occipital Sinus** lies along the posterior border of the falx cerebelli. It begins by small veins around the foramen magnum and ends in the confluence of sinuses. Usually there

are two occipital sinuses at the commencement which unite higher up to form a single trunk. Sometimes they remain separate in their entire course and each opens into the transverse sinus of its own side. It communicates below with the posterior internal vertebral venous plexus.

Dissection. To examine the cavernous sinus, cut through the dura mater occupying the side of the body of the sphenoidal bone from the anterior clinoid process to the apex of the petrous bone and lateral to the openings in this membrane for the oculomotor and trochlear nerves.

Cavernous Sinus.—This is a curved sinus so called because its lumen is traversed by intersecting bands. It lies on either side of the body of the sphenoidal bone. It begins in front at the superior orbital fissure where it receives the ophthalmic veins and ends behind at the apex of the petrous portion of the temporal bone in the superior and inferior petrosal sinuses. It communicates with its fellow of the opposite side by the intercavernous sinuses. In addition to the ophthalmic veins the sphenoparietal sinus opens into the cavernous sinus. Two emissary veins, one passing through the foramen ovale or foramen Vesalii and the other through the foramen lacerum, connect the cavernous sinus with the pterygoid plexus of veins outside the cranial cavity. The internal carotid plexus of veins accompanying the internal carotid artery also opens into the cavernous sinus and thus establishes communication with the pharyngeal venous plexus in the neck. The structures lying on the medial and lateral walls of the sinus will be examined later on.

The **Sphenoparietal Sinus** is a minute venous channel which passes medialwards along the under surface of the small wing of the sphenoidal bone and opens into the cavernous sinus.

The **Superior Petrosal Sinus** begins at the posterior end of the cavernous sinus and ends in the transverse sinus. It lies in a groove along the superior border of the petrous portion of the temporal bone.

The **Inferior Petrosal Sinus** runs along the groove formed by the articulation of the basilar part of the occipital bone with the posterior border of the petrous portion of the temporal bone. It begins in front in the cavernous sinus and ends behind in the internal jugular vein, after it has passed through the anterior compartment of the jugular foramen.

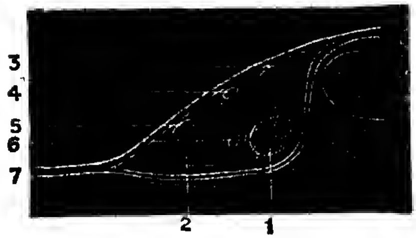
The **Intercavernous Sinuses** are two in number, an anterior

and a posterior. They connect the cavernous sinuses; the anterior passes in front and the posterior behind the diaphragma sellæ. The two intercavernous sinuses together with the intervening cavernous sinuses form a circular venous channel called *the circular sinus.*

The **Basilar Plexus** consists of minute venous channels between the two layers of the dura mater covering the basilar part of the occipital bone and establishes communication between the inferior petrosal sinuses of the two sides. Below it communicates with the anterior internal vertebral venous plexus.

Exit of the Cerebral Nerves.—The dissector has now to examine at the base of the skull the points at which the cerebral nerves pierce the dura mater and trace these up to the points where they leave the cranial cavity. As each nerve goes out it receives sheaths from each of the three coverings of the brain. The sheath derived from the arachnoid soon disappears, but those derived from the dura mater and pia mater are gradually lost on the nerve. The *olfactory nerves* are minute filaments, about twenty in number, which pierce the dura mater over the lamina cribrosa of the ethmoidal bone through the foramina of which they enter the nasal cavity. They are attached to the inferior surface of the olfactory bulb which has been removed with the brain. The *optic nerve* perforates the dura mater opposite the optic foramen and passes through it to the orbit. It is accompanied by the ophthalmic artery. The *oculomotor nerve* pierces the dura mater in front of and lateral to the posterior clinoid process. Trace this nerve in the lateral wall of the cavernous sinus to its exit from the cranial cavity through the superior orbital fissure. In the lateral wall of the cavernous sinus it communicates with the cavernous plexus of the sympathetic around the internal carotid artery and with the ophthalmic division of the trigeminal nerve by minute filaments. Before its exit through the superior orbital fissure it subdivides into a superior and an inferior ramus. The *trochlear nerve* pierces the dura mater at the free margin of the tentorium cerebelli behind and lateral to the posterior clinoid process. Traced in the cavernous sinus it is found to lie in its lateral wall between the oculomotor nerve above and the ophthalmic division of the trigeminal nerve below. Here it communicates with the cavernous plexus of the sympathetic and with the ophthalmic division of the trigeminal nerve by minute filaments. Before its exit through the superior orbital fissure it crosses the oculo-

motor nerve. The *trigeminal nerve* consists of a motor and a sensory root. Both the roots pierce the dura mater opposite

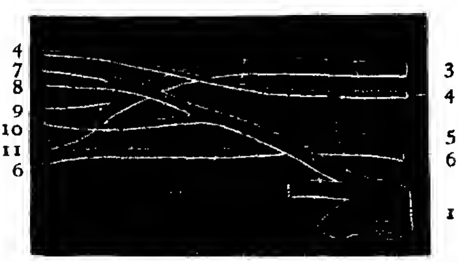


1. Internal carotid artery.
2. Lumen of the cavernous sinus.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Ophthalmic nerve.
6. Abducent nerve.
7. Dura mater.

Fig. 69.—Diagram showing the position of the nerves in the wall of the cavernous sinus.

the apex of the petrous portion of the temporal bone, the motor root lying to the medial side. On cutting through the dura mater and tracing the roots a ganglion, called the *semilunar ganglion* (Gasserian ganglion), is found on the sensory root. This ganglion lies on the trigeminal impression of the petrous portion of the temporal bone in a cavity (cavum Meckelii) between the two layers of the dura mater. Its convex margin is directed forwards and lateralwards and from it issue the three large nerves viz., the ophthalmic, maxillary and mandibular. Behind the ganglion lies the motor root of the trigeminal nerve. The medial end of the ganglion is joined by filaments from the cavernous plexus of the sympathetic. Trace the three branches of the trigeminal nerve to their exit from the cranial cavity. The *ophthalmic nerve* is the smallest of the three divisions of the trigeminal. It arises from the anteromedial part of the ganglion and passes

Superior orbital fissure. Carotid groove.



1. Semilunar ganglion.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Ophthalmic division of trigeminal nerve.
6. Abducent nerve.
7. Frontal nerve.
8. Lacrimal nerve.
9. Superior division of oculomotor nerve.
10. Naso-ciliary nerve.
11. Inferior division of oculomotor nerve.

Fig. 70—Diagram of the nerves passing through the superior orbital fissure and the carotid groove.

through the lateral wall of the cavernous sinus lying below the trochlear nerve. Before entering the orbit through the superior orbital fissure it divides into three branches ; frontal, nasociliary and lacrimal. In the wall of the cavernous sinus it communicates with the oculomotor, trochlear and abducent nerves and is joined by filaments from the cavernous plexus of the sympathetic. It gives off a meningeal branch which supplies the tentorium cerebelli. The student has traced three nerves along the lateral wall of the cavernous sinus and he should note their relative positions. The oculomotor nerve is the highest, the ophthalmic nerve the lowest and the trochlear nerve is intermediate in position. The *maxillary nerve* arises from the middle part of the convex border of the semilunar ganglion and passes forwards lateral to the cavernous sinus to the foramen rotundum through which it passes out of the cranial cavity. It gives off the middle meningeal nerve which supplies the dura mater of the middle fossa of the base of the skull. The *mandibular nerve* (inferior maxillary nerve) is the largest division of the trigeminal. It passes out of the cranial cavity through the foramen ovale and is joined by the motor root of the trigeminal nerve just after its exit through the foramen. The *abducent nerve* pierces the dura mater at the lower part of the dorsum sellæ where a notch exists for it on either side. It passes along the medial wall of the cavernous sinus lateral to the internal carotid artery covered by the lining membrane of the sinus. It enters the orbit through the superior orbital fissure. In the wall of the lateral sinus it communicates with the cavernous plexus of the sympathetic, and with the ophthalmic nerve. The *facial nerve*, the *nervus intermedius* and the *acoustic nerve* leave the cranial cavity through the internal acoustic meatus piercing the dura mater over it. The *glossopharyngeal, vagus* and *accessory nerves* pierce the dura mater over the jugular foramen and pass through its middle compartment. The aperture in the dura mater for the glossopharyngeal nerve is separate and is situated in front. The vagus and accessory nerves have a common aperture in the dura mater behind. The *hypoglossal nerve* pierces the dura mater over the hypoglossal canal in two separate bundles which unite together in the canal to form one trunk.

Cavernous Sinus.—The student should now fully examine the cavernous sinus. It is so named because its cavity presents a reticulate structure owing to its being traversed by a network of slender fibrous cords. On the lateral wall of the sinus are the

oculomotor, the trochlear, the ophthalmic and maxillary divisions of the trigeminal nerve; on its medial wall is the internal carotid artery surrounded by filaments of the carotid plexus; the abducent nerve runs forwards lateral to the artery. These structures are separated from the blood flowing in the sinus by a thin lining membrane of the sinus.

The dissector has now to examine the arteries entering into the cranial cavity. These are :—1. The internal carotid arteries. 2. The vertebral arteries. 3. The meningeal arteries.

Internal Carotid Artery.—The *cavernous portion* of this artery lies in the lateral surface of the body of the sphenoidal bone and should now be examined. The petrous portion of the artery traverses the carotid canal in the petrous portion of the temporal bone; it leaves the canal to enter the cranial cavity and runs through the cavernous sinus, constituting the cavernous portion of the artery. In this part of its course it lies between the two layers of the dura mater. Piercing the outer layer of the dura mater it passes forwards between the two layers along the medial wall of the cavernous sinus on the side of the body of the sphenoidal bone. It is separated here from the blood of the sinus by the lining membrane of the sinus. On reaching the medial side of the anterior clinoid process it passes upwards and pierces the inner layer of the dura mater. At this situation the artery has been divided at the time of the removal of the brain. The artery is surrounded by the cavernous plexus of the sympathetic. The abducent, oculomotor, trochlear and ophthalmic nerves all lie lateral to it. The *branches* given off from the cavernous portion of the internal carotid artery are :—(1) *cavernous branches*, which are small twigs and supply the wall of the cavernous sinus; (2) *hypophysial branches* which supply the hypophysis; (3) *semilunar branches* which are small twigs and supply the semilunar ganglion; and (4) *anterior meningeal branch* which crosses the small wing of the sphenoidal bone and supplies the dura mater of the anterior fossa of the base of the skull.

The **Vertebral Artery** pierces the dura mater below the foramen magnum and here it has been divided during the removal of the brain.

Meningeal Arteries.—These may be classified as follows :—

I. In the anterior cranial fossa—meningeal branches of (1) anterior ethmoidal artery, (2) posterior ethmoidal artery and (3) internal carotid artery.

II. In the middle cranial fossa—(1) middle meningeal

artery, (2) accessory meningeal artery and (3) meningeal branch of ascending pharyngeal artery.

III. In the posterior cranial fossa—(1) two meningeal branches of ascending pharyngeal artery, (2) meningeal branch of occipital artery and (3) meningeal branch of vertebral artery.

In the anterior cranial fossa of the base of the skull, the *meningeal branches* are derived from the anterior and posterior ethmoidal arteries as they enter the cranium through the anterior and posterior ethmoidal foramina. In addition the anterior meningeal branch of the internal carotid artery has been already noticed. These meningeal branches supply the dura mater and shine through it when the subject is well injected.

Dissection. Detach the dura mater carefully from the middle cranial fossa beginning at the cut margin of the skull and reflect it towards the foramen spinosum in the sphenoidal bone through which the middle meningeal artery enters the cranial cavity. Note that the dura mater is very firmly attached to the bones at the base of the skull and more firmly to the sutures.

In the middle cranial fossa the largest of the meningeal arteries viz., the **Middle Meningeal Artery**, is seen. It is a branch of the internal maxillary artery, and enters the cranial cavity through the foramen spinosum. On the great wing of the sphenoidal bone it divides into an anterior and a posterior branch. The *anterior branch*, the larger, passes along the great wing of the sphenoid and ascends along the groove on the inner surface of the sphenoidal angle of the parietal bone and divides into branches between the dura mater and the internal surface of the cranium; some proceed upwards and supply the dura mater as far as the vertex of the skull; others spread out backwards to the occipital region. The *posterior branch* runs upwards and backwards grooving the squamous part of the temporal bone and the squamous border of the parietal bone and spreads out into branches which supply the posterior part of the dura mater. The branches given off from the middle meningeal artery within the cranial cavity are :(1) *ganglionic branches* which supply the semilunar ganglion; and (2) *superficial petrosal branch* which enters the hiatus of the facial canal and supplies the facial nerve and the tympanic cavity; (3) *superior tympanic artery* which enters the semicanal for tensor tympani muscle to supply it; (4) *orbital branch* which enters the orbit through the superior orbital fissure and anastomoses with the lacrimal

artery ; (5) *temporal branches* which are minute twigs leaving the cranial cavity through foramina in the great wing of the sphenoid. In the temporal fossa they anastomose with the deep temporal branch of the internal maxillary artery. The *middle meningeal vein* is also called the *middle meningeal sinus* on account of its wide calibre and its course through the dura mater. It accompanies the middle meningeal artery and either opens into the cavernous sinus or leaves the cranial cavity through the foramen spinosum to open into the pterygoid plexus of veins. The *accessory meningeal artery* (small meningeal artery) is a branch of the internal maxillary artery or of its middle meningeal branch. It enters the cranial cavity through the foramen ovale and supplies the dura mater and the semilunar ganglion. A *meningeal branch* of the ascending pharyngeal artery enters through the foramen lacerum and supplies the dura mater of the middle cranial fossa.

In the posterior fossa of the base of the skull two *meningeal branches of the ascending pharyngeal artery* are seen. One enters the cranial cavity through the jugular foramen and the other through the hypoglossal canal. A *meningeal branch of the occipital artery* enters the cranial cavity through the jugular foramen. The *meningeal branch of the vertebral artery* enters the cranial cavity through the foramen magnum. All these meningeal branches supply the dura mater of the posterior fossa of the base of the skull.

The cavernous plexus of the sympathetic and some minute nerves entering the middle cranial fossa are now to be examined.

The *cavernous plexus of the sympathetic* surrounds the internal carotid artery specially on its lower and medial side when it traverses the medial wall of the cavernous sinus. It is the continuation upwards of the sympathetic plexus lying on the medial side of the internal carotid artery in the carotid canal. It sends communicating filaments to the oculomotor, trochlear, ophthalmic and abducent nerves and supplies twigs to the hypophysis and the sympathetic root of the ciliary ganglion in the orbit.

The *greater superficial petrosal nerve* will be seen lying beneath the semilunar ganglion. It has its origin from the genicular ganglion of the facial nerve and issues out of the petrous portion of the temporal bone through the hiatus of the facial canal. The petrosal branch of the middle meningeal artery also passes through this canal. The nerve enters the cartilaginous subs-

tance filling the foramen lacerum and unites in it with the deep petrosal nerve to form the nerve of the pterygoid canal.

The *deep petrosal nerve* is a branch of the carotid plexus of the sympathetic. It issues out of the carotid canal along the lateral side of the internal carotid artery and joins the greater superficial petrosal nerve in the foramen lacerum to form the nerve of the pterygoid canal.

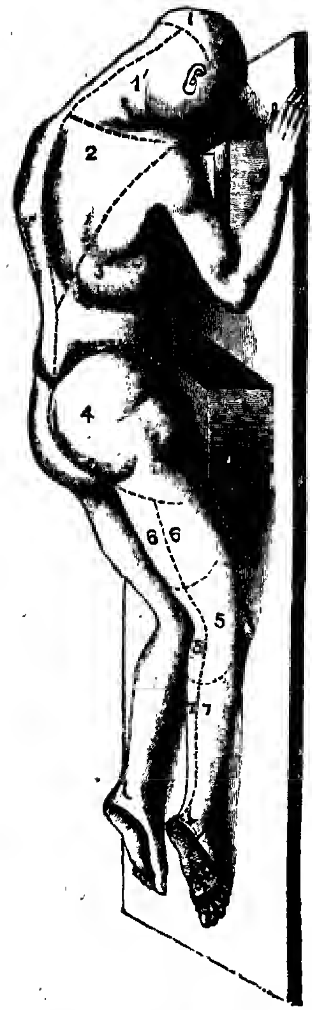


Fig. 71.—Posterior view of the body showing the lines of incisions for reflecting the integument.

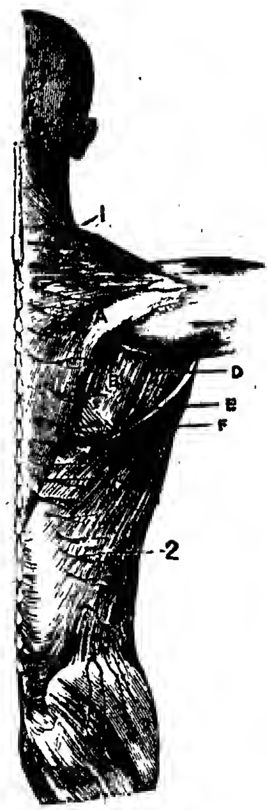
The *lesser superficial petrosal nerve* is formed by the union of a filament from the genicular ganglion of the facial nerve with the tympanic branch of the glossopharyngeal. It issues out of the petrous portion of the temporal bone through a slit just lateral to the hiatus of the facial canal. It leaves the cranial cavity through a slit between the petrous portion of the temporal bone and the great wing of the sphenoid, or through the foramen ovale to join the otic ganglion.

Nervus spinosus.—This minute nerve is a branch of the mandibular nerve outside the cranial cavity. It enters the cranial cavity through the foramen spinosum in company with the middle meningeal artery and supplies the dura mater.

DISSECTION OF THE BACK

Directions. On the fourth day the body is turned so that it lies on its face. The subject is allowed to remain in this position for four days. During the first two days the dissector of the head and neck dissects in conjunction with the dissector of the superior extremity till the muscles of the second layer are reflected.

Dissection. Make a longitudinal incision from the external occipital protuberance to the tip of the spinous process of the seventh cervical vertebra. From the lower end of this incision make a transverse incision to the



A. Trapezius.
B. Infraspinatus.
C. Latissimus dorsi,
D. Teres minor.
E. Teres major.
F. Rhomboideus major.
1. Cutaneous nerve (medial branch).
2. Cutaneous nerve (lateral branch).

Fig. 72.—Dissection showing the superficial muscles and cutaneous nerves of the back (after Cunningham). In the upper part the medial branches of the posterior divisions of the spinal nerves are cutaneous; in the lower part their lateral branches are cutaneous.

acromio-clavicular articulation. Reflect the skin laterally. (Fig. 71).

The **Superficial Fascia** is fatty and is a portion of the superficial fascia covering the whole body. In it the cutaneous vessels and nerves ramify.

The **Cutaneous Nerves** (Fig. 72) are the medial branches of the posterior divisions of the cervical nerves. The posterior division of the first cervical nerve usually gives off no cutaneous branch. The medial branch of the posterior division of the second cervical nerve is called the *great occipital nerve*. It pierces the trapezius near its attachment to the occipital bone and becomes cutaneous. Its termination has been noticed during the dissection of the scalp. The medial branch of the posterior division of the third cervical nerve is called the *third occipital nerve*. It pierces the trapezius and becomes cutaneous, medial to the great occipital nerve. It supplies the skin of the lower and back part of the head close to the medial line. The medial branches of the posterior division of the fourth and fifth cervical nerves pierce the trapezius lower down close to the spinous processes; those of the lower three cervical nerves do not become cutaneous, but are exhausted in muscles.

The *deep fascia* is a portion of the fascia colli and is very dense. At the lateral border of the trapezius it splits to enclose the muscle.

Muscles of the Back.—The following table shows the arrangement in layers of the muscles of the back and the work assigned to the dissectors of head and neck and superior extremity:—

First layer	Trapezius.	Dissectors of head and neck and superior extremity.
	Latissimus dorsi.	Dissector of superior extremity.
Second layer	Rhomboidei.	
	Splenius cervicis and capitis. Serratus posterior superior and inferior.	Dissector of head and neck.
	Levator scapulæ. Inferior belly of omohyoid.	Dissectors of head and neck and superior extremity.

Layer	Muscles	Dissector
Third layer	Sacro-spinalis and its prolongations. Semispinalis capitis.	Dissector of head and neck.
Fourth layer	Multifidus. Rotatores. Interspinales. Intertransversarii. Levatores costarum. Rectus capitis posterior major. Rectus capitis posterior minor. Obliquus capitis superior. Obliquus capitis inferior.	

Dissection. The trapezius is now to be cleaned. Remove the superficial layer of the deep fascia from its surface. Its lower portion below the level of the seventh cervical spine must be cleaned by the dissector of the superior extremity. The whole work at the trapezius should be done in conjunction with him.

The **Trapezius** (Fig. 73) is triangular in shape and arises from (1) the medial third of the superior nuchal line of the occipital bone, (2) the external occipital protuberance, (3) the ligamentum nuchæ, (4) the tip of the spinous process of the seventh cervical vertebra, and (5) the spinous processes of all the thoracic vertebræ and the supraspinous ligaments connecting them. The upper fibres pass obliquely downwards and lateralwards; the middle fibres horizontally; and the lower fibres upwards and lateralwards. It is inserted (1) into the posterior border of the lateral third of the clavicle by its upper fibres; (2) into the medial border of the acromion and the upper lip of the posterior border of the spine of the scapula by its middle fibres; and (3) into the tubercle at the commencement of the spine of the scapula by its lower fibres. Before the lower fibres are inserted into the tubercle, they end in an aponeurosis which glides over the smooth triangular surface at the apex of the spine of the scapula. The anterior free border of the muscle forms the posterior boundary of a triangular space called the posterior triangle of the neck. *Actions.*—It draws the scapula medialwards and braces back the

shoulder. Its upper fibres elevate the tip of the shoulder; the middle and lower fibres rotate the scapula so that the shoulder is elevated. The muscle extends the head when the scapula is fixed. *Nerve-supply.*—It is supplied by the accessory nerve and the third and fourth cervical nerves.

Dissection. Divide the trapezius in two places: (1) at its occipital origin and (2) half an inch lateral to its attachment to the whole length of the ligamentum nuchæ and throw it lateralwards in conjunction with the dissector of the superior extremity. While reflecting the muscle note the process of the fascia colli which passes beneath it. The accessory nerve and branches from the third and fourth cervical nerves are seen to enter its deep surface. The ascending branch of the transverse cervical artery is seen to pass upwards beneath the muscle. The following muscles are now exposed:—the levator scapulæ, the inferior belly of the omo-hyoid, the rhomboidei major and minor, the serratus posterior superior and inferior and the splenius capitis.

The **Levator Scapulæ** (Levator anguli scapulæ) arises from the posterior parts of the transverse processes of the first and second cervical vertebræ and from the posterior tubercles of the transverse processes of the third and fourth cervical vertebræ. It is inserted into the vertebral border of the scapula between its medial angle and the triangular smooth surface at the root of the spine. It is supplied by branches from the anterior divisions of the third and fourth cervical nerves which enter its superficial surface. It usually gets a branch from the dorsal scapular nerve which passes beneath it. It raises the scapula and also depresses the shoulder.

The inferior belly of the **Omohyoideus** arises from the superior transverse ligament of the scapula and the adjacent upper border of the scapula.

The student should now observe that the *transverse scapular artery* passes over the superior transverse scapular ligament and that the suprascapular nerve passes through the scapular notch below the ligament. The *ascending branch of the transverse cervical artery* (superficial cervical artery) passes upwards between the trapezius and the splenius and anastomoses with the superficial branch of the descending ramus of the occipital artery. The *descending branch* of the transverse cervical artery (posterior scapular artery) passes beneath the levator scapulæ to the medial angle of the scapula and descends along its vertebral border

to its inferior angle. This artery will be traced by the dissector of the superior extremity.

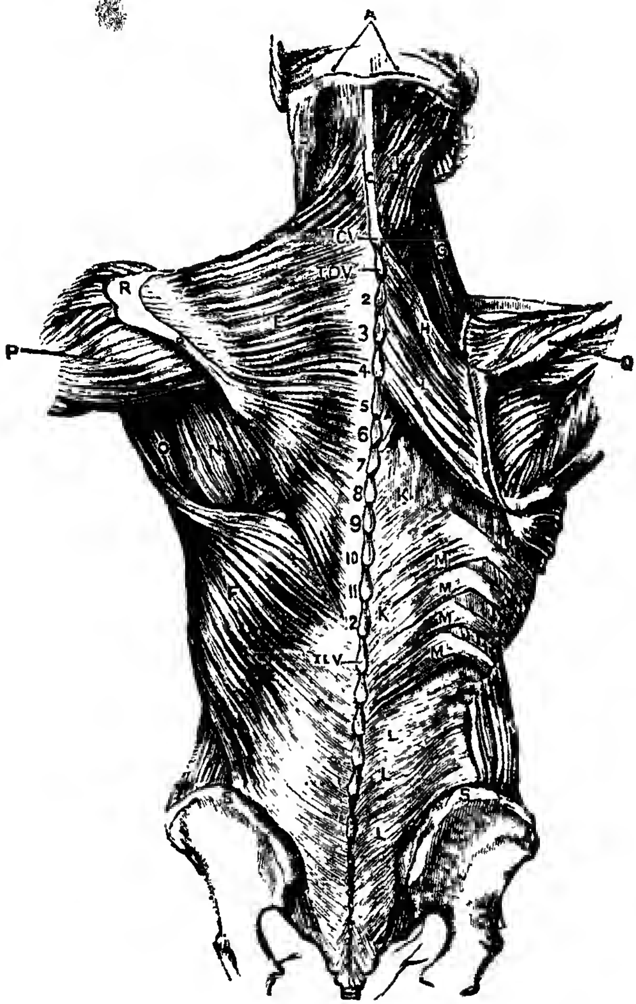


Fig. 73.—Muscles of the back (modified from Gray). The first layer of muscles in seen on the left side and the second and third layers, on the right side.

A. Occipital bone.
B. Superior nuchal line.
C. Ligamentum nuchæ.
D. Sterno-cleido-mastoideus.
E. Trapezius.
K. Lumbodorsal fascia (thoracic portion).
L. Lumbodorsal fascia (lumbar portion).
M. Serratus posterior inferior.

F. Latissimus dorsi.
G. Levator scapulæ.
H. Rhomboideus minor.
I. Rhomboideus major.
J. Splenius capitis et colli.
N. Infraspinatus.
O. Teres major.
P. Deltoideus.
Q. Spine of scapula.
R. Acromion.
S. Crest of ilium.

The **Serratus Posterior Superior** is a thin quadrilateral muscle placed on the back part of the thorax. It arises by an aponeurosis (1) from the lower part of the ligamentum nuchæ and (2) from the spinous processes of the seventh cervical and upper two or three thoracic vertebræ. It passes downwards and lateralwards and is inserted by digitations into the outer surfaces of the second, third, fourth and fifth ribs in front of their angles. It is supplied by intercostal nerves, second to fifth inclusive. It raises the ribs into which it is inserted and is an inspiratory muscle.

The **Serratus Posterior Inferior** is also placed on the posterior aspect of the thorax but broader than the preceding muscle. It arises by an aponeurosis (1) from the spinous processes of the last two thoracic and upper two lumbar vertebræ and (2) from the supraspinous ligaments. This aponeurotic origin is blended with the lumbodorsal fascia. It is inserted by digitations into the outer surfaces of the lower four ribs a little in front of their angles. It is supplied by the intercostal nerves, ninth to twelfth inclusive. It fixes the lower ribs and by helping the diaphragm becomes a muscle of inspiration.

The **Lumbodorsal Fascia** (Fig. 74) covers the deep muscles of the back and consists of a thoracic and a lumbar portion.

The *thoracic portion of the lumbodorsal fascia* (Vertebral aponeurosis) is thin but strong and is attached laterally to the angles of the ribs and medially to the spinous processes of the thoracic vertebræ. These attachments can be verified by making a longitudinal incision along the middle of the fascia and by introducing the handle of the scalpel both medially and laterally. Traced above, the fascia is seen to pass beneath the serratus posterior superior to become continuous with the deep fascia of the neck. Below it is continuous with the posterior lamella of its lumbar portion.

The *lumbar portion of the lumbodorsal fascia* (Lumbar fascia) is thick and strong and consists of three lamellæ viz., a posterior, a middle and an anterior. These three lamellæ unite together laterally where they form the source of origin of the obliquus internus and transversus abdominis.

Dissection. Remove the remains of the latissimus dorsi which arise from the lumbodorsal fascia. Divide the serratus

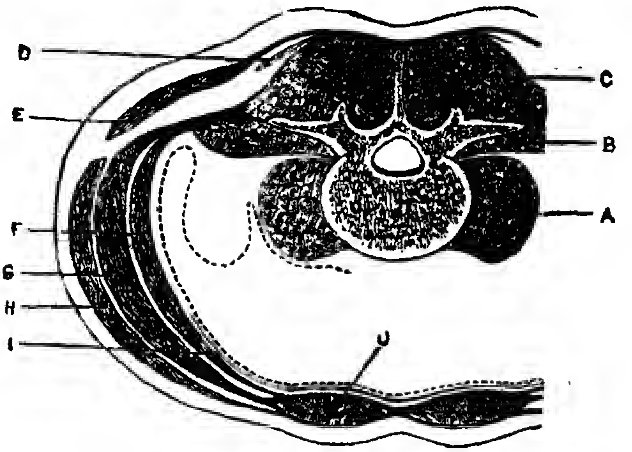


Fig. 74.—Diagram to illustrate the connections of the lumbodorsal fascia (after Cunningham).

A. Psoas major.	F. Transversus abdominis.
B. Quadratus lumborum.	G. Obliquus internus abdominis.
C. Sacrospinalis.	H. Obliquus externus abdominis.
D. Serratus posterior inferior.	I. Fascia transversalis.
E. Latissimus dorsi.	J. Rectus abdominis.

posterior inferior vertically and reflect the two portions medially and laterally; while reflecting observe that its origin is blended with the lumbodorsal fascia and that its nerves are entering into its deep surface. The posterior lamella of the lumbar portion of the lumbodorsal fascia is exposed.

The *posterior lamella* is the thickest and covers the sacrospinalis. It is blended superficially with the aponeurotic origin of the latissimus dorsi and the serratus posterior inferior. Above it is continuous with the thoracic portion of the fascia. Below it is attached to the outer lip of the iliac crest and to the posterior surface of the sacrum and coccyx. Medially it is attached to the spinous processes of the lumbar and sacral vertebræ. Laterally it gives origin to the internal oblique and transversus abdominis. From its anterior surface at the lateral edge of the sacrospinalis it sends off medialwards the middle lamella of the fascia.

Dissection. To display the middle lamella make a longitudinal incision in the posterior lamella a little medial to the lateral edge of the sacrospinalis from the last rib to the iliac crest. From

the upper and lower ends of this incision make a transverse incision medially towards the spinous processes. Reflect the quadrilateral flap of the posterior lamella medialwards. The sacrospinalis is now exposed. Raise the lateral edge of the sacrospinalis and push it medially. The middle lamella lying in front of the muscle is now exposed.

The *middle lamella* is attached medially to the tips of the transverse processes of the lumbar vertebræ. Laterally it blends with the posterior lamella at the lateral margin of the sacrospinalis. Above it is attached to the last rib and below to the iliolumbar ligament.

Dissection. To display the anterior lamella divide the middle lamella longitudinally at the lateral edge of the sacrospinalis. The posterior surface of the quadratus lumborum is exposed. Introduce the finger through this incision and carry it along the lateral edge of the quadratus lumborum. On raising the muscle and pushing it medially the anterior lamella is seen.

The *anterior lamella* or *fascia covering the quadratus lumborum* is attached medially to the anterior surfaces of the roots of the transverse processes of the lumbar vertebræ. Laterally it is attached to the blended middle and posterior lamellæ at the lateral edge of the quadratus lumborum and constitutes the source of origin of the transversus abdominis. Above, it forms a thickened band called the *lateral lumbocostal arch*. Below it is attached to the iliolumbar ligament.

The student should note that the three lamellæ of the lumbar portion of the lumbodorsal fascia unite at the lateral margins of the sacrospinalis and quadratus lumborum and form two compartments, an anterior which lodges the quadratus lumborum and a posterior, the sacrospinalis.

Dissection. Divide the serratus posterior close to its origin from the spinous processes and reflect it lateralwards. Note the branches of the intercostal nerves entering its deep surface. Now study the splenius.

The **Splenius** is a single muscle at its origin but soon divides into two portions a cervical portion called splenius cervicis and a cranial portion called splenius capitis. It arises (1) from the lower half of the ligamentum nuchæ and (2) the spinous processes of the seventh cervical and upper six thoracic vertebræ. The *splenius cervicis* is inserted into the posterior aspects of the transverse processes of the upper two or three cervical vertebræ. The *splenius capitis* is inserted under cover of the sterno-cleido-

mastoideus (1) into the lower part of the mastoid portion of the temporal bone and (2) into the occipital bone below the lateral part of the superior nuchal line. The splenius cervicis and capitis are supplied by the lateral branches of the posterior divisions of the cervical nerves. The muscles of the two sides carry the head directly backwards ; the muscles of one side turn the head to the same side.

Dissection. Reflect the splenius muscle upwards and lateralwards towards the cranium by dividing it at its origin. Preserve the nerves piercing the muscle. Remove the thoracic portion of the lumbodorsal fascia together with the remains of the posterior lamella of its lumbar portion and also the insertion of the serratus posterior inferior.

The **Sacrospinalis** (Erector spinæ) (Fig. 75) is a single fleshy mass at its origin in the sacral and lumbar regions. It arises (1) from the spinous processes of all the lumbar vertebræ and the corresponding supraspinous ligaments, (2) from the middle and lateral sacral crests, (3) from the posterior sacroiliac ligament, (4) from the posterior part of the inner lip of the iliac crest and (5) from the anterior surface of the posterior lamella of the lumbodorsal fascia. Traced upwards the fleshy mass becomes differentiated into three columns, a lateral, an intermediate, and a medial. The lateral column separates itself in the upper lumbar region while the medial column, in the upper thoracic region. The lateral column is called the iliocostalis ; the intermediate column, the longissimus ; and the medial column, the spinalis.

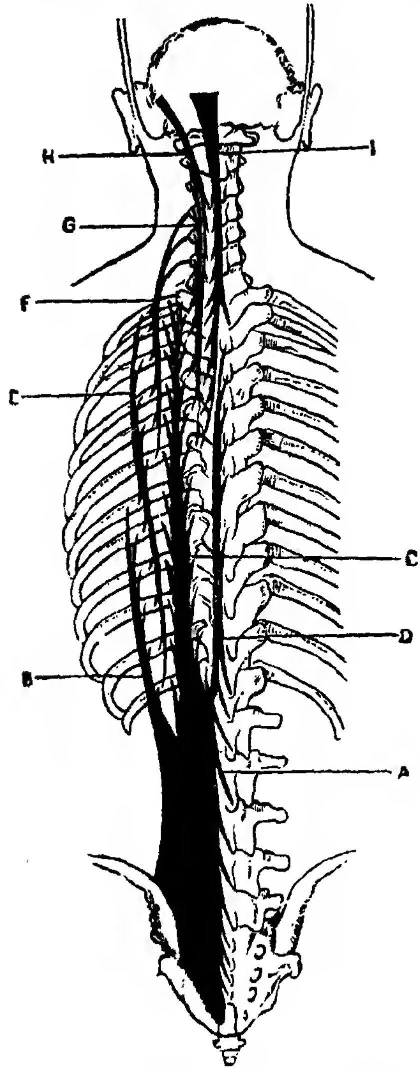
Dissection. Differentiate the three columns of the sacrospinalis by first pushing laterally the iliocostalis and then separating the longissimus from the spinalis. The slips of each portion of the three divisions should then be defined.

The **Iliocostalis** (Sacrolumbalis) is prolonged upwards into the neck and is separable into three portions according to its situation, viz., iliocostalis lumborum, iliocostalis dorsi, and ilocostalis cervicis.

The *iliocostalis lumborum* is inserted by six or seven tendinous slips into the angles of the lower six or seven ribs.

The *iliocostalis dorsi* (Accessorius) arises by six or seven tendinous slips from the angles of the lower six or seven ribs just medial to and covered by the tendons of insertion of the iliocostalis lumborum. It is inserted by separate tendinous slips into the angles of the upper six ribs and into the back part of the transverse process of the seventh cervical vertebra.

The *iliocostalis cervicis* (Cervicalis ascendens) arises by tendinous slips from the angles of the third, fourth, fifth and sixth ribs just medial to the tendons of insertion of the iliocostalis dorsi. It is inserted into the posterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ.



A. Sacrospinalis.

B. Iliocostalis lumborum.

C Longissimus dorsi.

D. Spinalis dorsi.

E. Iliocos'alis dorsi.

F. Iliocostalis cervicis.

G. Longissimus cervicis.

H. Longissimus capitis.

I. Semispinalis capitis.

Fig. 75.—Diagrammatic representation of the different portions of the sacrospinalis muscle (modified from Cunningham).

The **Longissimus** is prolonged upwards into the head and is separable into three portions according to their situation, viz., longissimus dorsi, longissimus cervicis and longissimus capitis.

The *longissimus dorsi* is inserted medially by tendinous slips into the transverse processes of the thoracic vertebræ and into the accessory processes of the lumbar vertebræ. Laterally it is inserted into the lower nine or ten ribs in the intervals between their tubercles and angles, and into the transverse processes of the lumbar vertebræ and to the posterior surface of the middle lamella of the lumbodorsal fascia.

The *longissimus cervicis* (Transversalis colli) is the prolongation upwards of the longissimus dorsi into the neck. It arises by tendinous slips from the tips of the transverse processes of the upper four thoracic vertebræ medial to the insertion of the longissimus dorsi and is inserted by similar tendinous slips into the posterior tubercles of the transverse processes of all the cervical vertebræ except the first and the last.

The *longissimus capitis* (Trachelo-mastoid) is the prolongation upwards of the longissimus cervicis on to the skull. It arises (1) from the transverse processes of the upper four thoracic vertebræ and (2) from the articular processes of the lower four cervical vertebræ. It is inserted into the mastoid portion of the temporal bone beneath the insertion of the splenius capitis and sterno-cleido-mastoideus.

The **Spinalis** is separable into two portions, spinalis dorsi and spinalis cervicis. The *spinalis dorsi* is not distinctly demarcated from the longissimus dorsi lying lateral to it. It arises from the spinous processes of the upper two lumbar and lower two thoracic vertebræ and is inserted into the spinous processes of the upper thoracic vertebræ, the number varying from four to eight. It is blended with the semispinalis dorsi lying beneath it. The *spinalis cervicis* is not constant. When present it arises from the spinous process of the fifth, sixth and seventh cervical vertebræ and occasionally also from those of the first and second thoracic vertebræ and is inserted into the spinous process of the second and sometimes also into those of the third and fourth cervical vertebræ.

Nerve-supply.—The various parts of the sacrospinalis are supplied by the posterior divisions of the spinal nerves. *Actions.*—These muscles draw the spine backwards and extend it and thus maintain the erect position of the spine when required. The cervical and cranial prolongations have similar

actions on the neck and head. The muscle of one side acting alone will bend the vertebral column to that side.

The **Semispinalis Capitis** (Complexus) is not a prolongation of the sacrospinalis but is a separate muscle being the cranial prolongation of the semispinalis muscle. It is to be noted that the semispinalis forms an independent column by itself and is divisible into three parts, the semispinalis dorsi, the semispinalis cervicis, and the semispinalis capitis. The semispinalis capitis arises by tendinous slips from the transverse processes of the upper six thoracic vertebræ, and from the articular processes of the fourth, fifth and sixth cervical vertebræ. It is inserted into an impression between the superior and inferior nuchal lines of the occipital bone close to the medial nuchal line. The medial part of this muscle is more or less separate from the remainder of the muscle and presents two fleshy bellies and an intermediate tendon ; hence, it is called the *biventer cervicis.* The semispinalis capitis is supplied by the posterior divisions of the upper cervical nerves. It moves the head backwards.

Dissection. Divide the longissimus capitis at its middle and reflect the upper part as far upwards as possible with the splenius capitis. The second part of the occipital artery is now seen.

The **Occipital Artery**, in the second part of its course, emerges from underneath the posterior margin of the sterno-cleido-mastoideus. Beneath the origin of the sternocleidomastoideus the artery is covered in addition by the longisimus capitis and the splenius capitis which have been reflected. From the posterior margin of the sternocleidomastoideus it crosses the interval between it and the lateral border of the trapezius, passes beneath the latter muscle and pierces it near its origin from the superior nuchal line lateral to the external occipital protuberance. Its terminal portion which ramifies over the scalp, has been examined. In its course it crosses the origin of the semispinalis capitis. Two or three lymph glands accompany this portion of the artery. They are called the *occipital lymph glands* which drain lymph from the occipital area of the scalp. Their efferents pass to the superior deep cervical lymph glands. The branches given off from the occipital artery here are :—(1) The *descending branch* (arteria princeps cervicis) which passes downwards to the lateral border of the semispinalis capitis and divides into a superficial and a deep branch. The superficial branch descends between the splenius capitis and the semispinalis, supplies these muscles

and anastomoses with the ascending branch of the transverse cervical artery. The deep branch descends under cover of the semispinalis capitis to anastomose with the arteria profunda cervicis, a branch of the costocervical artery. This anastomosis will be seen when the semispinalis capitis will be reflected. (2) The *meningeal branch,* a small twig, enters the cranial cavity through the mastoid foramen to supply the dura mater of the posterior cranial fossa. (3) The *muscular branches* supply the neighbouring muscles. The *occipital veins* open into the vertebral and deep cervical veins. Occasionally one of the veins accompanies the artery and opens into the internal jugular vein. An emissary vein usually connects it with the transverse sinus through the mastoid foramen.

Dissection. Divide the semispinalis capitis at its insertion into the occipital bone and reflect it with care laterally. Note that it is pierced by the medial branches of the posterior divisions of the cervical nerves. Of these the greater occipital nerve is of large size and supplies the muscle with a branch. A twig from the posterior division of the suboccipital nerve will be seen entering the deep surface of the muscle while it is reflected. The anastomosis between the descending branch of the occipital artery and the arteria profunda cervicis is now exposed. The suboccipital triangle is also brought into view. Remove the spinalis dorsi to expose the semispinalis dorsi lying underneath.

The **Semispinalis Dorsi** arises from the transverse processes of the sixth to the tenth thoracic vertebræ and is inserted into the spinous processes of the upper four thoracic and lower two cervical vertebræ.

The **Semispinalis Cervicis** arises from the transverse processes of the upper five thoracic vertebræ and is inserted into the spinous processes of the cervical vertebræ from the second to the fifth inclusive.

The semispinales dorsi and cervicis are supplied by the posterior divisions of the thoracic and cervical nerves. They extend the corresponding portion of the vertebral column.

Dissection. Cut the semispinales dorsi and cervicis at their insertion into the spinous processes of the vertebræ and throw them lateralwards. Detach the sacrospinalis from the sacral and lumbar spinous processes and throw it lateralwards. The multifidus is now fully exposed.

The **Multifidus** arises (1) from the back of the sacrum as low as the fourth posterior sacral foramen, (2) from the overlying

aponeurosis of the sacrospinalis, (3) from the posterior sacroiliac ligament, (4) from the posterior superior iliac spine, (5) from the mamillary processes of all the lumbar vertebræ, (6) from the transverse processes of all the thoracic vertebræ, and (7) from the articular processes of the lower four cervical vertebræ. The muscular slips pass upwards and medialwards and are inserted into the whole length of the spinous processes of all the lumbar, thoracic and cervical vertebræ except the atlas. The superficial fasciculi skip over two or three vertebræ before their insertion. The deep fasciculi run from one vertebra to the second or third above. The multifidus is supplied by the posterior divisions of the spinal nerves. It bends backwards the different portions of the vertebral column.

The **Rotatores** are short muscular slips exposed on reflecting the multifidus. They are eleven in number on each side. Each arises from the upper and back part of the root of a transverse process in the thoracic region, beginning from the second thoracic and becomes inserted into the lower border and lateral surface of the lamina of the vertebra above. They are supplied by the posterior divisions of the spinal nerves. They rotate the individual vertebræ to the opposite side.

The **Interspinales** are short muscular fasciculi placed in pairs between the contiguous spinous processes in the cervical and lumbar regions. In the upper and lower thoracic regions they are poorly developed and are altogether absent in the midthoracic region. In the lumbar region they are well marked and placed on either side of the interspinous ligament. They are supplied by the posterior divisions of the spinal nerves. They bend the vertebral column backwards.

The **Intertransversarii** lie between the transverse processes. In the lumbar region they are well developed and are arranged in two sets: the *intertransversarii laterales* passing between the transverse processes; the *intertransversarii mediales* extending from the accessory process of the vertebra above to the mamillary process of the vertebra below. In the thoracic region they are absent in the upper part and poorly developed between the lower three or four transverse processes. In the cervical region they exist in pairs between the anterior and posterior tubercles of the transverse processes and are known respectively as the *intertransversarii anteriores* and *posteriores*. The intertransversarii are supplied by the anterior divisions of the spinal nerves, except the medial intertransverse muscles which are

supplied by the posterior divisions. They bend the vertebral column laterally to their own side.

Dissection. Remove the remains of the iliocostalis and longissimus from the thoracic region without injuring the blood vessels and nerves. Remove also the multifidus over the sacrum to display the nerves.

Levatores Costarum.—These are twelve fan-shaped muscles arising by their apices from the tips of the transverse processes of the seventh cervical and the upper eleven thoracic vertebræ. Each is inserted by a broad base into the rib below between its tubercle and angle. They are supplied by the posterior divisions of the spinal nerves. They slightly elevate and evert the ribs and hence help the muscles of inspiration.

Vessels of the Back.—(I) In the cervical region these are :—(1) The *occipital artery* with its branches which has been examined. (2) The *arteria profunda cervicis* is a branch of the costo-cervical artery. It appears at the back part of the neck between the transverse process of the seventh cervical vertebra and the neck of the first rib and ascends between the semispinalis capitis and semispinalis cervicis to anastomose with the descending branch of the occipital artery. Its companion vein begins in the suboccipital venous plexus and opens into the vertebral vein. (3) Minute *muscular branches* from the vertebral artery supply the muscles at the back part of the neck. (4) A part of the *vertebral artery* is seen in the suboccipital triangle.

(II) In the thoracic region the arteries are derived from the posterior branches of the *intercostal arteries*. They accompany the posterior branches of the intercostal nerves and supply the muscles and skin of the back. The companion veins open into the intercostal veins.

(III) In the lumbar region the arteries are derived from the posterior branches of the *lumbar arteries* and have a distribution like that in the thoracic region. Their companion veins open into the lumbar veins.

(IV) In the sacral region the arteries are derived from the terminal branches of the *lateral sacral arteries* which emerge from the posterior sacral foramina and are accompanied by the posterior divisions of the sacral nerves. They supply the skin and muscles on the dorsum of the sacrum. The companion veins open into the lateral sacral veins.

Nerves of the Back.—These are derived from the posterior divisions of the spinal nerves. They appear at the back between

the transverse processes in the cervical, thoracic and lumbar regions. There are thirty-one pairs of spinal nerves and with the exception of four nerves (the first cervical, the fourth and fifth sacral and the coccygeal) each posterior division divides into a medial and a lateral branch. As a general rule it may be said that the medial branches of the posterior divisions down to the posterior division of the sixth thoracic spinal nerve supply muscles and then become cutaneous to supply the skin; whereas the lateral branches of these nerves are exhausted in supplying the muscles and do not become cutaneous. From the seventh thoracic spinal nerve downwards the distribution of the posterior divisions is reversed, viz., the lateral branches supply the muscles and integument as well; whereas the medial branches are exhausted in supplying the muscles only and do not become cutaneous.

(I) **Posterior divisions of the cervical nerves.**—The posterior division of the *first cervical* or *suboccipital nerve* is purely muscular and will be studied during the dissection of the suboccipital triangle. The posterior division of the second cervical nerve is very large. Its medial branch is very long and is called the *great occipital nerve* which has been seen to pierce the semispinalis capitis and trapezius and supply the skin of the scalp. Its lateral branch supplies the splenius, longus capitis, and semispinalis capitis. The medial branch of the posterior division of the *third cervical nerve* gives off a cutaneous branch called the *third occipital nerve* which ascends to the scalp medial to the great occipital nerve; its lateral branch joins with that of the second cervical. The medial branches of the *fourth* and *fifth cervical nerves* become cutaneous by piercing the trapezius near the spinous processes; those of the *sixth, seventh* and *eighth cervical nerves* are exhausted in supplying the muscles and do not become cutaneous. The lateral branches of the posterior divisions of the lower five cervical nerves supply the neighbouring muscles and do not become cutaneous.

(II) *Posterior divisions of the thoracic nerves.*—The medial branches of the upper six thoracic nerves supply the multifidus and sacrospinalis and become cutaneous by piercing the trapezius near the spinous processes; those of the lower six nerves are exhausted in supplying the multifidus. The lateral branches of the upper six thoracic nerves supply the lateral and intermediate prolongations of the sacrospinalis and do not become cutaneous; those of the lower six nerves supply the muscles and

become cutaneous by emerging in a line with the angles of the ribs.

(III) *Posterior divisions of the lumbar nerves.*—The medial branches of these nerves supply the multifidus. The lateral branches of the upper three nerves are large. They supply the sacrospinalis, pierce the posterior lamella of the lumbodorsal fascia and descend across the iliac crest to become cutaneous in the gluteal region. The lateral branches of the fourth and fifth lumbar nerves supply the muscles and give off no cutaneous branches.

(IV) *Posterior divisions of the sacral nerves.*—Those of the upper three emerge from the posterior sacral foramina and divide into medial and lateral branches. The medial branches are lost in the multifidus. The lateral branches form loops with each other. From these loops twigs are given off which pierce the sacrotuberous ligament and the glutæus maximus to supply the skin of the gluteal region. The posterior division of the fourth sacral nerve emerges from the fourth posterior sacral foramen, while that of the fifth sacral nerve, from the lower end of the sacral canal. These two nerves do not divide into medial and lateral branches but communicate with each other and with the third sacral above and the coccygeal nerve below. They supply the skin over the lower part of the sacrum and the back of the coccyx.

(V) The *posterior division of the coccygeal nerve* emerges from the lower end of the sacral canal and does not divide into a medial and a lateral branch. It communicates with the fifth sacral nerve above and supplies the back of the coccyx.

The *posterior external vertebral venous plexus* is a network of veins situated on the external surfaces of the laminæ, the spinous, the articular and the transverse processes of the vertebræ. The student will notice some of these venous channels beneath the multifidus. This plexus receives blood from the skin and muscles of the back, and ends in the intercostal veins in the thoracic region, in the lumbar veins in the lumbar region, and in the vertebral veins in the cervical region.

The **Ligamentum Nuchæ** is a triangular fibrous partition interposed in the middle line of the back of the neck between the muscles of the two sides. Its apex is attached to the spinous process of the seventh cervical vertebra; its base to the external occipital protuberance and to the median nuchal line. Its anterior border is attached to the posterior tubercle of the atlas

and the spinous processes of the remaining cervical vertebræ. Its posterior border is the continuation upwards of the supraspinous ligament from the spinous process of the seventh cervical vertebra to the external occipital protuberance and gives origin to some muscles of the back.

Dissection. The dissector should now clean the muscles which bound the suboccipital triangle as also the rectus capitis posterior minor. He should next trace any one of the nerve twigs (ending in one of these muscles) towards its origin and it will lead to the posterior division of the suboccipital nerve which lies on the posterior arch of the atlas and beneath the vertebral artery. After the parent nerve has been found he should trace from it the nerve twigs to the other muscles of this space. It should be observed that a branch is given off from the nerve which divides into two twigs, of which one supplies the rectus capitis posterior major while the other crosses the surface of the muscle to supply the rectus capitis posterior minor. It should also be observed that the nerve to the obliquus capitis inferior sends a communicating twig to the greater occipital nerve. He should then expose the vertebral artery which lies on the sulcus arteria vertebralis of the atlas, the posterior arch of the atlas, and the posterior atlanto-occipital membrane.

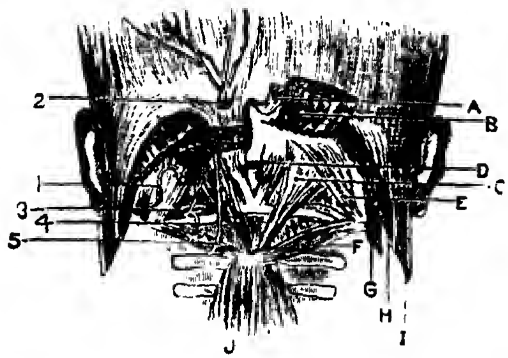


Fig. 76.—Dissection of the suboccipital triangle (from J. T. Gray).

A. Trapezius.
B. Semispinalis capitis.
C. Rectus capitis posterior major.
D. Rectus capitis posterior minor.
E. Obliquus capitis superior.
F. Obliquus capitis inferior.
G. Longissimus capitis.
H. Splenius capitis.
I. Sterno-cleido-mastoideus.
J. Semispinalis colli.
1. Occipital artery.
2. Occipital artery and great occipital nerve.
3. Vertebral artery.
4. Suboccipital nerve.
5. Great occipital nerve.

The **Suboccipital Triangle** (Fig. 76) is a triangular space *bounded* above and medially by the rectus captis posterior major; above and laterally by the obliquus capitis superior; and below by the obliquus capitis inferior. Its *roof* is formed by the semi-spinalis capitis. Its *floor* is formed by the posterior arch of the atlas and the posterior atlanto-occipital membrane. Its *contents* are the vertebral artery and the posterior division of the sub-occipital nerve

The **Rectus Capitis Posterior Major** arises from the spinous process of the epistropheus (Axis) and is inserted into the lateral part of the inferior nuchal line of the occipital bone and to the surface of the bone below it. It rotates and extends the head, turning the face to the same side. It is supplied by the posterior division of the suboccipital nerve.

The **Obliquus Capitis Inferior** arises from the spinous process of the epistropheus and is inserted into the lower and back part of the transverse process of the atlas. It turns the face to the same side by rotating the atlas on the axis. It is supplied by the posterior division of the suboccipital nerve.

The **Obliquus Capitis Superior** arises from the upper and back part of the transverse process of the atlas and is inserted into the occipital bone between the superior and inferior nuchal lines and lateral to the inserion of the semispinalis capitis. By the action of both nuscles the head is drawn backwards. If one muscle acts alone the head is inclined to the opposite side. It is supplied by the posterior division of the suboccipital nerve.

The **Rectus Capitis Posterior Minor** lies on the medial side of the rectus capitis posterior major. It arises from the tubercle on the posterior arch of the atlas and is inserted into the medial part of the inferior nuchal line of the occipital bone and to the surface of the bone below it. It extends the head and is supplied by the posterior division of the suboccipital nerve.

Vertebral Artery.—The third part of the vertebral artery is seen in the suboccipital triangle. It issues from the foramen in the transverse process of the atlas, passes backwards and medi-alwards, and lies on the sulcus arteria vertebralis of the atlas; the posterior division of the suboccipital nerve lies between the artery and the sulcus in the bone. It then enters the vertebral canal by passing through the gap between the lateral margin of the posterior atlanto-occipital membrane and the superior articular process of the atlas and pierces the dura mater.

The **Posterior division of the Suboccipital Nerve** emerges

from beneath the vertebral artery as it lies on the sulcus on the posterior arch of the atlas. It does not divide into medial and lateral branches but at once breaks up into branches which supply the three muscles forming the boundaries of the sub-occipital triangle and also the rectus capitis posterior minor and semispinalis capitis.

Dissection. The dissector has now to lay open the whole of the vertebral canal from behind. For this purpose the laminæ and spinous processes of the vertebræ are to be cleaned throughout the whole length of the vertebral column by removing the remains of the multifidus and rotatores. The posterior divisions of the spinal nerves are to be thrown laterally. The laminæ are then to be sawn through just medial to the articular processes commencing from the laminæ of the third cervical vertebra to those of the sacrum. The saw is to be used a little obliquely with the cutting edge turned slightly medialwards. When using the saw in any region that particular region should be made tense by placing a block underneath The neck is made tense by allowing the head to hang over the edge of the table. In the lumbar region it is convenient to use the chisel and hammer. The laminæ with the intervening ligamenta flava are then to be removed in one mass. The dura mater of the medulla spinalis is now exposed covered by some loose areolar tissue and fat in which are seen embedded minute arteries and plexuses of veins.

The *ligamenta flava* (Ligamenta subflava) fill up the gap between the adjacent laminæ. Each ligament is attached above to the lower margin and the adjacent anterior surface of the lamina of the upper vertebra and below to the upper margin and the adjacent posterior surface of the lamina of the lower vertebra. Laterally it is continuous with the articular capsule and medially it is fused with the ligament of the opposite side; minute gaps exist for the exit of small veins from the interior of the vertebral canal. These ligaments are broad in the cervical and lumbar regions and are composed of yellow elastic tissue. They serve to maintain the erect position of the vertebral column and help to regain that position after flexion.

The *interspinous ligaments* extend from the root to the tip of the spinous processes of adjacent vertebræ. Each ligament is continuous in front with the ligamenta flava and behind with the supraspinous ligament. These ligaments are well developed in the lumbar region and are weak in the cervical and thoracic regions.

The *supraspinous ligaments* extend between the tips of the spinous processes. In the neck they are represented by the ligamentum nuchæ.

The *posterior internal vertebral venous plexus* consists of two longitudinal plexuses one on either side of the middle line situated between the laminæ and ligamenta flava behind, and the dura mater covering the medulla spinalis in front. They communicate (1) with each other by transverse branches, (2) with the posterior external vertebral venous plexus outside the canal by branches passing through the ligamenta flava, (3) with the anterior internal vertebral venous plexus in front which now remains covered by the dura mater and (4) with the occipital sinus above. They send laterally branches which unite with similar branches from the anterior internal vertebral venous plexus to form intervertebral veins.

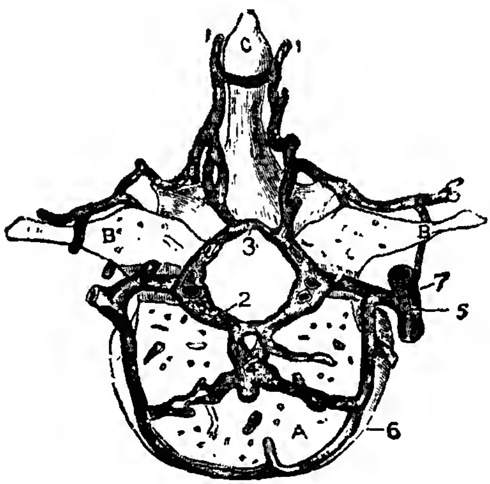


Fig. 77.—Diagram illustrating the vertebral venous plexuses (Gray).

A. Body of thoracic vertebra.
B. Transverse process.
C. Spinous process.
1. Posterior external venous plexus.
2. Anterior internal venous plexus.
3. Posterior internal venous plexus.
4. Venæ basis vertebræ.
5. Intercostal vein.
6. Anterior external venous plexus.
7. Intervertebral vein.

Spinal Arteries.—These supply the medulla spinalis and its membranes and the bones and ligaments of the vertebral

canal. In well injected subjects they are readily seen. *In the cervical region* they are derived from (1) the vertebral artery, (2) the ascending cervical artery and (3) the arteria profunda cervicis. *In the thoracic region* they are derived from the posterior branches of the intercostal arteries. *In the lumbar region* they are derived from the posterior branches of the lumbar arteries, and *in the sacral region* from the lateral sacral arteries. They enter the vertebral canal through the intervertebral or anterior sacral foramina and each artery divides into three branches, of which one, called the *lateral spinal artery*, pierces the dura-mater with the spinal nerve to supply the medulla spinalis. Of the other two, one passes in front of and the other behind the dura mater. These two anastomose with the branches of the arteries above and below thus forming anastomosing loops throughout the length of the canal. They also anastomose with the arteries of the opposite side by minute transverse twigs.

The **Membranes of the Medulla Spinalis** are three in number. From without inwards they are called the dura mater, the arachnoid and the pia mater.

The *dura mater* that is now exposed corresponds to the meningeal layer of the cranial dura mater. The endosteal layer of the cranial dura mater is continued down into the vertebral canal as the periosteum lining the bones which bound the canal. The space between the wall of the vertebral canal and spinal dura mater is called *epidural space* and contains areolar tissue and plexuses of veins. The venous plexuses on the surface of the dura mater spinalis correspond to the sinuses of the dura mater inside the cranium. Above the spinal dura mater is attached to the margin of the foramen magnum. Below it extends as far as the lower margin of the second sacral vertebra. Here it is suddenly narrowed and prolonged as an adherent sheath of the filum terminale which is a thread-like structure continued from the termination of the medulla spinalis. As a sheath of the filum terminale it is prolonged over the back part of the coccyx where it blends with the periosteum covering that bone. Laterally it is prolonged as sheaths on the spinal nerves which pierce it. It presents two bulgings, one in the cervical region and the other in the lumbar region.

Dissection. Slit open the dura mater along the middle line without injuring the subjacent arachnoid. The *inner surface of the dura mater* is seen to be smooth and glistening. It is separated from the arachnoid by a capillary space called

the *subdural cavity*. Note that laterally corresponding to each spinal nerve there are two openings in the dura mater, one for the anterior and the other for the posterior root. Note also that it does not send processes from its inner surface like the cranial dura mater.

The *arachnoid* is a very thin delicate membrane and surrounds the medulla spinalis loosely. It is continuous above with the arachnoid of the brain. The loose sheath is largest below where it covers the lumbar enlargement of the medulla spinalis and the bunch of nerves prolonged downwards forming the cauda equina. Laterally it is prolonged over the spinal nerve roots forming sheaths for them. The *subarachnoid cavity* is a wide interval between the arachnoid and the pia mater and contains cerebro-spinal fluid. It is continuous above with that in the cranium. Below the space is the largest where it encloses the nerves constituting the cauda equina and hence can be easily demonstrated. It is imperfectly subdivided into three compartments by three septa, one posterior and two lateral. The posterior septum is called the *subarachnoid septum* (septum posticum) and connects the inner surface of the arachnoid with the pia mater over the posterior surface of the medulla spinalis. The lateral septa are called the ligamenta denticulata and will be studied in detail later on.

Dissection. Remove the arachnoid carefully from a part of the medulla spinalis and expose the pia mater beneath.

The *pia mater* is closely adherent to the entire surface of the medulla spinalis. It is less vascular but thicker than the cerebral pia mater. It consists of two layers between which the blood vessels of the medulla spinalis ramify before they enter its substance. Above it is continuous with the pia mater covering the brain. Below where the medulla spinalis ends it gradually contracts and is continued downwards through the centre of the cauda equina as an investment of the filum terminale. It is firmly adherent to the medulla spinalis opposite the postero-median septum. Laterally it is thickened into a longitudinal band, called the *ligamentum denticulatum*, and is prolonged on the spinal nerves as sheaths for them.

The **Medulla Spinalis** (Spinal cord) occupies the upper two-thirds of the vertebral canal. It is almost cylindrical in form being slightly flattened from before backwards and has an average length of about eighteen inches (45 cm.). It extends from the foramen magnum to the lower margin of the first lumbar vertebra

where it ends in a tapering cone called the *conus medullaris.* From the apex of the cone a narrow filament is continued downwards as far as the back part of the coccyx, called the filum terminale. In the cervical and lower thoracic regions it presents enlargements. The *cervical enlargement* extends from the level of the third cervical vertebra to the first or second thoracic vertebra ; to it the nerves of the upper limbs are attached. The *lumbar enlargement* lies opposite the last three thoracic vertebræ ; to it the nerves of the lower limbs are attached.

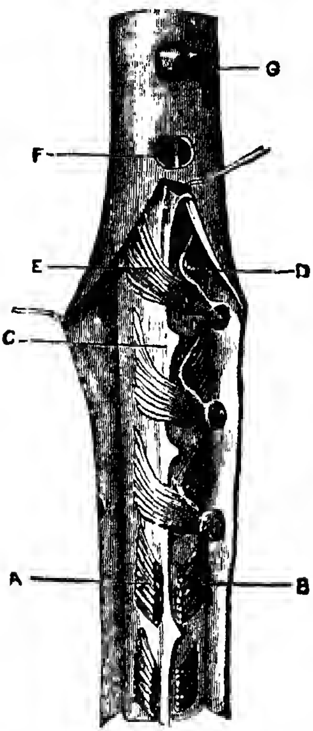
The **Filum Terminale** is the slender filament prolonged from the tip of the conus medullaris and placed in the middle of the bunch of nerves called the *cauda equina* but it can be easily distinguished from them by its silvery colour and by its terminating in the conus medullaris. It consists chiefly of pia mater ; its upper part encloses a small amount of nervous substance. The central canal of the medulla spinalis is prolonged into its upper part. Opposite the lower border of the second sacral vertebra it pierces the tube of dura mater and receives an adherent sheath from it. Then it descends to be blended with the periosteum covering the back part of the coccyx. The upper potion of it within the tube of dura mater is called the *filum terminale internum* and the lower portion with the adherent sheath of the dura mater is called the *filum terminale externum.*

Spinal Nerves.—There are thirty-one pairs of spinal nerves which arise from the medulla spinalis ; eight pairs cervical twelve pairs thoracic, five pairs lumbar, five pairs sacral, and one pair coccygeal.

I. **Mode of exit.**—As a general rule each spinal nerve in the cervical, thoracic and lumbar regions issues out of the vertebral canal through the intervertebral foramen and the sacral nerves come out through the sacral foramina. But there are exceptions: thus the first cervical nerve passes out between the occipital bone and the atlas ; the second cervical nerve passes out across the arch of the epistropheus ; and the fifth sacral nerve and the coccygeal nerve come out through the lower opening of the sacral canal.

II. **Nerve roots.**—Each spinal nerve is formed by two roots, an anterior or motor root and a posterior or sensory root. The attachments of these roots to the surface of the medulla spinalis will be clearly seen after its removal from the body (p. 245). The *anterior root* issues from the anterior surface of the medulla spinalis by several filaments which are spread out rather

irregularly at the attached area but unite to form two bundles near the intervertebral foramen. The *posterior root* is larger than the anterior—except in the first cervical nerve where it is smaller than the anterior root; its filaments are attached in a regular line to the postero-lateral fissure of the medulla spinalis; these unite to form two bundles which end in the spinal ganglion.



Dissection. Cut away with bone forceps the contiguous articular processes of some of the thoracic vertebræ to see the ganglia on the posterior roots and also the subsequent fusion of both the roots to form the nerve trunks.

III. **Spinal ganglion**.—A swelling called the spinal ganglion, is seen on each of the posterior roots within the intervertebral foramen before its union with the anterior root. A minute branch, called the *ramus meningeus*, is given off from each spinal nerve after its exit from the intervertebral foramen and immediately before it splits into an anterior and a posterior division; this branch again enters the vertebral canal through the intervertebral foramen and unites with a filament from the sympathetic trunk. It supplies the vertebræ, their periosteum and the meninges of the medulla spinalis.

IV. **Size and direction of nerve roots**.—The roots of the upper cervical nerves are short and directed transversely lateralwards. The roots of the lower cervical and upper thoracic nerves are directed obliquely downwards; the obliquity and

Fig. 78.—Lateral view of the medulla spinalis showing dura mater, ligamentum denticulatum and anterior and posterior nerve roots (from Hirschfeld and Leveille).

A. B. Fasciculi of origin of nerve roots.
C. Ligamentum denticulatum.
D. Anterior nerve root.
E. Posterior nerve root.
F. Section through nerve roots.
G. Spinal nerve with its sheath of dura mater.

length of the successive nerves increase from above downwards. The roots of the lower thoracic, lumbar, sacral and coccygeal nerves are very long and directed vertically downwards around the medulla spinalis. This bundle of long nerve roots descending from the lower end of the medulla spinalis is called the *cauda equina* from its resemblance to a horse's tail. It is to be noted that the length of the roots of the lower thoracic nerves is equal to the depth of two vertebræ and the length of each successive root of the lumbar and sacral nerves is a vertebra longer on account of the fact that the medulla spinalis does not extend beyond the first lumbar vertebra.

V. **Situation of the ganglion.**—As a rule the student will find the ganglion on the posterior root after its exit through the dura mater lying within the intervetebral foramen and the

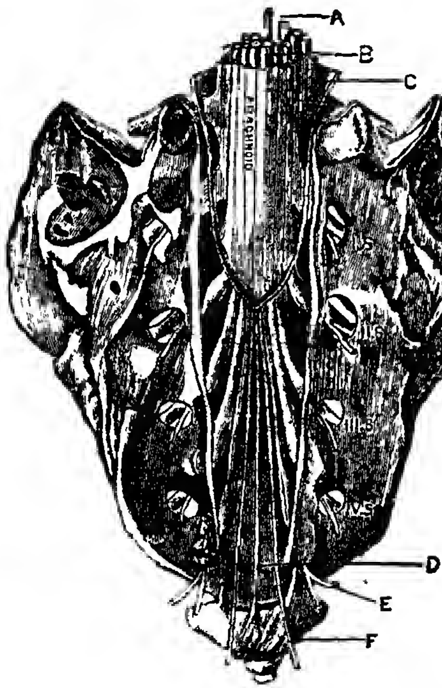


Fig. 79.—Sacral canal laid open from behind, showing the lower part of the cauda equina and the membranes lying in relation (from Testut).

A. Filum terminale.
B. Cauda equina.
C. Dura mater.
D. Filum terminale.
E. Fifth sacral nerve.
F. Coccygeal nerve.

union of the anterior and posterior roots takes place within the same foramen. But there are certain exceptions to this: thus the ganglia on the posterior roots of the first two cervical nerves lie on the vertebral arches of the atlas and epistropheus; the ganglion on the posterior roots of the sacral nerves are developed within the sacral canal and the union of their anterior and posterior roots also takes place within the same canal. The ganglion on the posterior root of the coccygeal nerve is developed before it pierces the dura mater and its two roots blend within the sacral canal.

VI. **Formation of spinal nerve trunks and their divisions.**—Each spinal nerve is formed by the blending of the anterior and posterior roots immediately beyond the spinal ganglion. The spinal nerve trunk is very short and immediately divides into an anterior and a posterior division. Only the spinal nerve trunks of the sacral and coccygeal nerves are a little long and their division takes place within the sacral canal.

VII. **Connections with the sympathetic.**—The connections of the spinal nerves in the cervical, thoracic and abdominal regions with the ganglia of the sympathetic will be seen during the dissection of those respective parts. But it may be conveniently mentioned here that after its exit from the intervertebral foramen, each spinal nerve gives off a branch, *white ramus communicans* to the neighbouring sympathetic ganglion in the case of the thoracic and first and second lumbar nerves. But each spinal nerve without exception receives a branch, *grey ramus communicans* from a neighbouring sympathetic ganglion.

VIII. **Spinal segments or neuromeres.**—These are portions of the medulla spinalis, the length of each of which is equal to the extent of attachment of a pair of spinal nerves.

Removal of the medulla spinalis with its membranes.—Divide the medulla spinalis with its membranes at the upper end of the vertebral canal exposed from behind. Divide the nerves keeping them as long as possible attached to the medulla spinalis. In the thoracic region some of the nerve roots have been traced through the intervertebral foramina to their fusion to form nerve trunks. Divide these nerve trunks. Lift the medulla spinalis with the attached nerves and detach the filum terminale from the back of the coccyx. Remove the medulla spinalis with the membranes intact. Note that the dura mater is attached anteriorly to the posterior longitu-

dinal ligament of the vertebræ by fibrous strands. Place the medulla spinalis with its membranes on a thin light piece of wood with its anterior surface uppermost and fix it with pins. The piece of wood should be of the same length as the medulla spinalis and about two inches in breadth. Divide the dura mater with scissors along the median line; reflect the flaps on either side and fix their margins with pins on the piece of wood. The subdural cavity is opened up and the arachnoid is seen. Remove the arachnoid carefully. The pia mater on the anterior surface of the medulla spinalis is seen.

The *pia mater* sends a process into the antero-median fissure of the medulla spinalis and presents a longitudinal thickened band along the middle line of its anterior surface called the *linea splendens*. An arterial trunk, called the *antero-median spinal artery*, descends along this band. Laterally the pia mater gives off a band which extends on each side and throughout the whole length of the medulla spinalis. This band is called the *ligamentum denticulatum* and supports the medulla spinalis by fixing itself to the dura mater. Its lateral margin presents twenty-one dentations or tooth-like processes, the pointed ends of which are attached at intervals to the inner surface of the dura mater. Its medial border is attached between the anterior and posterior roots of the spinal nerves in a continuous line from the foramen magnum to the level of the first lumbar vertebra.

The *anterior internal vertebral venous plexus* should now be examined in the anterior wall of the vertebral canal. It consists of two longitudinal venous trunks one on either side of the posterior longitudinal ligament of the vertebræ. They communicate (1) with each other opposite the body of each vertebra by a transverse branch which is covered by the posterior longitudinal ligament and into which the basivertebral vein opens. Above they communicate (2) with the basilar plexus or with the occipital sinus and behind (3) with the posterior internal vertebral plexus. Laterally they send off branches towards the intervertebral foramina which join with similar branches from the posterior venous plexus to form the *intervertebral veins*. These intervertebral veins open into the vertebral veins in the neck, into the intercostal veins in the thorax, into the lumbar veins in the lumbar region, and into the lateral sacral veins in the sacral region.

Arteries of the Medulla Spinalis.—There are five arterial

channels running longitudinally along the medulla spinalis. One runs downwards longitudinally along the antero-median fissure beneath the linea splendens and is called the ***antero-median spinal artery.*** It is formed near the foramen magnum by the meeting of the two anterior spinal branches of the vertebral artery. It is reinforced in the different regions by the lateral spinal arteries (p. 240). This trunk is prolonged for some distance into the filum terminale. The *postero-lateral spinal arteries* are four in number, two on each side, one lying in front of and the other behind the attachment of the posterior spinal nerve roots of the medulla spinalis. They begin in the right and left posterior spinal branches of the vertebral artery in the foramen magnum. Each divides into two branches one passing in front of and the other behind the posterior spinal nerve roots. These branches are reinforced in the different regions by the lateral spinal arteries. They terminate at the lower end of the medulla spinalis and are not prolonged over the filum terminale. Of the lateral spinal arteries in the different regions, some go to join the antero-median artery and the rest join the postero-lateral arteries, and when a lateral spinal artery gives a branch to the former it does not send another branch to the latter.

Veins of the Medulla Spinalis.—These form plexuses on the surface of the medulla spinalis. Six longitudinal trunks can be recognised amongst these plexuses; one runs along the antero-median fissure beneath the arterial trunk. Another runs along the postero-median fissure. The other four run laterally, two on each side, one in front of and the other behind the posterior nerve roots. These trunks communicate freely with each other and send branches laterally along the nerve roots to join the internal vertebral venous plexuses.

Directions. The naked eye structure of the medulla spinalis now remains to be studied. For this purpose the medulla spinalis is to be hardened sufficiently before any sections can be made. Put the medulla spinalis in the same jar in which the brain has been preserved and the same lotions will harden it.

SIDE OF THE NECK

Directions. On the eighth day after the subject has been placed in the dissecting-room, the dissection of the side of the neck is commenced. The subject is turned on its back and blocks are placed beneath the shoulders, chest and pelvis. The

side of the neck is made tense by drawing the head backwards and turning the face to the opposite side. Replace the trapezius muscle in its position.

The area known as "the side of the neck" is quadrilateral in outline. It is *bounded*, in *front* by the middle line of the neck, *behind* by the anterior margin of the trapezius, *above* by the lower border of the mandible and a line drawn from the angle of the mandible along the mastoid process to the superior nuchal line of the occipital bone; *below*, by the clavicle. The sterno-cleido-mastoid muscle crosses the space diagonally from above downwards and forwards and divides it into two triangles. The anterior triangle is placed in front of the muscle and the posterior triangle behind it (Fig. 89).

Surface Anatomy.—Before the skin is reflected the following landmarks should be recognised. In the middle line of the neck from above downwards are :—(1) the symphysis menti, (2) the body of the hyoid bone, (3) the hyothyreoid membrane lying between the hyoid bone and the thyreoid cartilage, (4) the anterior border of the thyreoid cartilage with the laryngeal prominence (pomum Adami), (5) the crico-thyreoid membrane lying in the short gap between the thyreoid and cricoid cartilages, (6) the cricoid cartilage, (7) the isthmus of the thyreoid gland (sometimes felt crossing the third and fourth rings of the trachea), and (8) the lower rings of the trachea (felt in emaciated subjects only). By turning the face to the opposite shoulder the diagonal prominence of the sterno-cleido-mastoideus is seen extending from the mastoid process to the sternal end of the clavicle and to the sternum.

Dissection. The following incisions should be made :—(1) A vertical incision along the middle line of the neck from the chin to the superior border of the sternum ; (2) a transverse incision from the lower end of the former incision along the clavicle to the acromion ; (3) a diagonal incision along the anterior margin of the sterno-cleido-mastoideus from the mastoid process to the point of meeting of the first two incisions at the sternum (Fig. 4). Reflect the anterior triangular flap of skin from below upwards over the mandible and the posterior flap backwards.

Superficial Fascia.—In the male subject the superficial fascia is very thin and contains very little fat. It can scarcely be dissected out as a separate membrane and the fibres of the platysma are seen through it.

The **Platysma** is a thin subcutaneous muscular sheet lying

over the anterior and posterior triangles of the neck. It arises below the clavicle from the superficial fascia over the deltoideus and the pectoralis major. The fibres of the muscle pass over the clavicle and proceed upwards and medialwards. The most anterior fibres interlace with the fibres of the opposite side below the symphysis menti. The posterior fibres are inserted into the mandible below the oblique line; some of the fibres pass upwards and intermingle with the muscles about the angle of the mouth and will be seen during the dissection of the face. It is supplied by the cervical branch of the facial nerve which enters its deep surface. *Actions.*—When the whole muscle acts it causes a wrinkling of the skin of the neck; its anterior portion depresses the mandible; its posterior portion draws the corner of the mouth downwards and lateralwards.

Dissection. Divide the platysma over the clavicle and reflect it upwards towards its insertion. Take care that the external and anterior jugular veins, the superficial branches of the cervical plexus and the cervical branch of the facial nerve which lie beneath the muscle are not injured. In cleaning the external jugular vein from the angle of the mandible, note that as it passes obliquely over the sterno-cleido-mastoideus it crosses the nervus cutaneus colli and after quitting that muscle it passes downwards and backwards and pierces the deep fascia above the middle of the clavicle. Trace the six cutaneous branches of the cervical plexus. Of these the smaller occipital and great auricular nerves ascend to the scalp and face respectively. The termination of the smaller occipital nerve has already been seen during the dissection of the scalp. Trace it towards the posterior margin of the sterno-cleido-mastoideus. The great auricular nerve will be seen below the auricula. The distribution of its posterior branch over the mastoid process has been examined during the dissection of the scalp. Trace it also towards the posterior border of the sterno-cleido-mastoideus. The three supraclavicular nerves pierce the deep fascia above the clavicle and cross the medial third, middle third, and the lateral third of the clavicle respectively. The nervus cutaneus colli ramifies in the anterior triangle of the neck after crossing the middle of the sterno-cleido-mostoideus transversely. Trace also the cervical branch of the facial nerve from near the angle of the mandible where it pierces the fascia colli up to its termination in the platysma Note its communication with the nervus cutaneus colli beneath the platysma.

The **External Jugular Vein** is formed by the union of the posterior auricular vein and the posterior division of the posterior facial vein in the substance of the parotid gland just behind the angle of the mandible. It runs down vertically along a line drawn from the angle of the lower jaw to the middle of the clavicle, crossing obliquely in its course the sterno-cleido-mastoideus. It pierces the deep fascia of the neck above the clavicle to open into the subclavian vein. Above, in the substance of the parotid gland it communicates by a branch with the internal jugular vein ; in the middle of its course it receives the posterior external jugular vein from the occipital region ; and lower down before opening into the subclavian vein it receives the transverse cervical, transverse scapular and anterior jugular veins. The external jugular vein lies closely related to some lymph glands, four to six in number, called the *superficial cervical lymph glands* whose efferent vessels dip at the anterior margin of the sterno-cleido-mastoideus to open into the superior deep cervical lymph glands. Their afferents are derived from the parotid region and lower part of the auricula.

The **Anterior Jugular Vein** is formed in the submaxillary region by the union of some small superficial veins. It runs down vertically close to the middle line of the neck. Above the medial end of the clavicle the vein pierces the deep fascia, proceeds lateralwards beneath the sterno-cleido-mastoideus and opens either into the external jugular or into the subclavian vein. Above the sternum and between the two layers of the fascia colli, a communication takes place between the anterior jugular veins of the two sides by a transverse branch called the *venous jugular arch*. The anterior jugular vein may be absent on one side. Its size varies inversely with that of the external jugular vein.

Superficial Branches of the Cervical Plexus (Fig. 80).—These emerge at the posterior border of the sterno-cleido-mastoideus at about its middle and may be grouped into (1) ascending branches viz., the smaller occipital nerve and the great auricular nerve, (2) transverse branch or nervus cutaneus colli, and (3) the descending branches viz., the supraclavicular nerves.

The **Smaller Occipital Nerve** is derived from the anterior division of the second cervical nerve. It runs upwards along the posterior border of the sterno-cleido-mastoideus, pierces the deep fascia and divides into mastoid, auricular and facial branches. Its distribution to the scalp has been examined (p. 201).

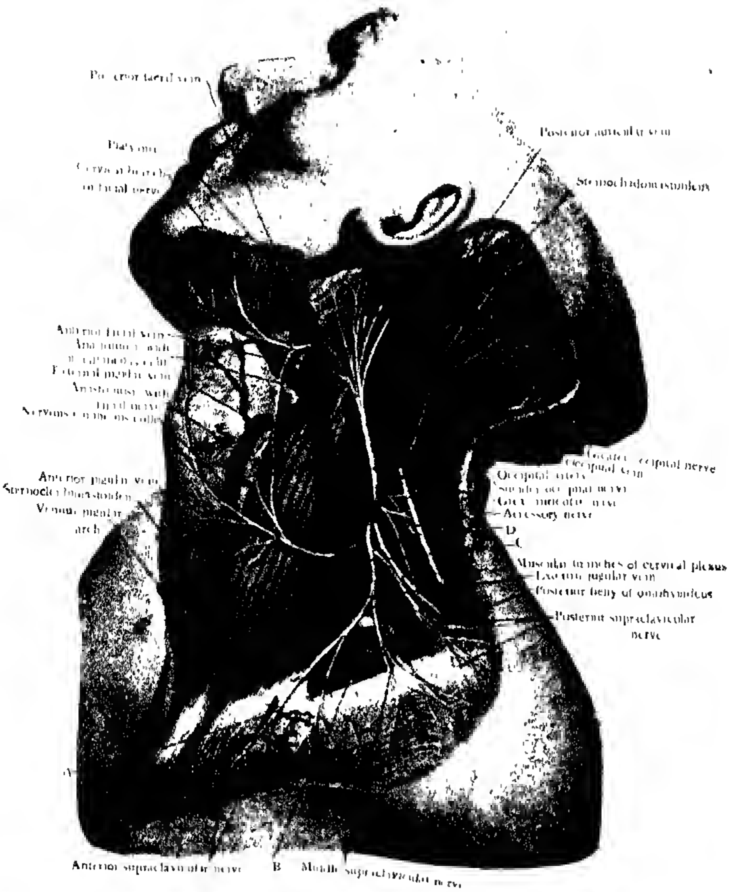


Fig. 80.—Superficial dissection of the Triangles of the Neck (Sobotta).

To face P. 250

The **Great Auricular Nerve** is derived from the anterior divisions of the second and third cervical nerves. It crosses the sterno-cleido-mastoideus obliquely and runs upwards towards the ear. It divides into two branches, an anterior and a posterior. The distribution of the posterior branch over the mastoid process and the auricula has been examined (p. 200). The anterior branch supplies the skin over the parotid gland and will be traced during the dissection of the face.

The **Nervus Cutaneus Colli** (Transverse cervical nerve) is derived from the anterior divisions of the second and third cervical nerves. It passes forwards to the anterior triangle of the neck crossing the sterno-cleido-mastoideus horizontally. In the anterior triangle it perforates the deep fascia and divides into ascending and descending branches. The *ascending branches* communicate with the cervical branch of the facial nerve and perforating the platysma, supply the skin of the submaxillary region. The *descending branches* pass downwards, pierce the platysma and supply the skin at the lower and front part of the neck.

The **Supraclavicular Nerves** originate from a single trunk derived from the anterior divisions of the third and fourth cervical nerves. This trunk appears beneath the posterior border of the sterno-cleido-mastoideus at about its middle and soon divides into three branches, viz., anterior, middle and posterior supraclavicular nerves. The *anterior supraclavicular nerves* (suprasternal branches) run downwards and medialwards, pierce the deep fascia above the clavicle and cross its medial third to supply the skin over the sternum. While crossing the sternal end of the clavicle they furnish one or two twigs to supply the sterno-clavicular articulation. The *middle supraclavicular nerves* (supraclavicular branches) pierce the deep fascia above the clavicle and cross its middle third to supply the skin over the pectoralis major and deltoideus. The *posterior supraclavicular nerves* (supraacromial branches) pierce the deep fascia at a higher level than the other supraclavicular nerves and descend over the trapezius and the acromion to supply the skin over the upper and back parts of the shoulder.

The **Cervical Branch of the Facial Nerve** pierces the fascia colli near the angle of the mandible and proceeds forwards beneath the platysma, communicating with the ascending branches of the nervus cutaneus colli. It enters the deep surface of the platysma to supply it.

The **Fascia Colli** (Deep cervical fascia) constitutes a complete investment for all the structures of the neck and sends off processes from its deep surface subdividing the enclosed space into compartments. At this stage of dissection the student observes the fascia as it roofs in both the anterior and posterior triangles of the neck. As the dissection proceeds he should study the processes that are given off from its deep surface. During the dissection of the back of the neck the deep fascia was seen to cover both surfaces of the trapezius muscle and then to be attached behind to the ligamentum nuchæ. At the anterior border of the muscle these two layers reunite to form a single layer which passes forwards covering the posterior triangle. At the posterior margin of the sterno-cleido-mastoideus this layer splits to enclose the muscle. At the anterior margin of the muscle the two layers reunite (except near the sternum) to form a single layer which is continued to the middle line of the neck to be continuous with the fascia of the opposite side. At the anterior margin of the lower part of the sterno-cleido-mastoideus, close to the sternum, these two layers do not unite but pass as separate layers to the middle line to be continuous with the similar two layers of the opposite side. Thus an interval is left between these two layers a superficial and a deep—at the upper border of the manubrium sterni, called the *suprasternal space* (space of Burns). The superficial layer is attached to the anterior border and the deep layer to the posterior border of the upper end of the sternum. Make a transverse incision through the superficial layer and note that the suprasternal space contains (1) the lower ends of the anterior jugular veins and the transverse branch of communication between them; (2) the sternal origins of the sterno-cleido-mastoideus; (3) a little areolar tissue containing fat, and (4) sometimes a lymph gland. *In the middle line* the fascia colli is attached to the body of the hyoid bone and to the symphysis menti. *Above* it is attached to the lower border of the mandible as far back as its angle. Behind the angle it splits to enclose the parotid gland; the superficial layer covering it superficially and the deep layer passing under the gland. The former is called the *parotideo-masseteric fascia* and extends upwards to be attached to the zygomatic arch. From the deep layer three bands, viz., the stylo-mandibular, spheno-mandibular, and pterygo-spinous ligaments are given off, which will be studied later on. Further back the fascia colli is attached above to the mastoid process and

superior nuchal line of the occipital bone. *Below* the fascia is attached to the manubrium sterni, to the clavicle and the

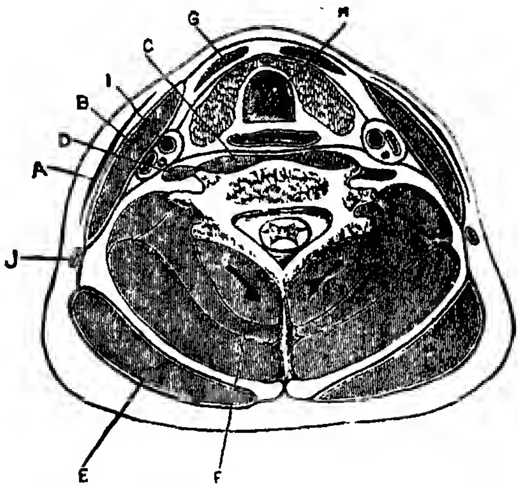


Fig. 81.—Transverse section through the lower part of the neck, to show the arrangements of the deep cervical fascia (diagrammatic)—from Treves.

A. Platysma.
B. Sterno-cleido-mastoideus.
C. Prevertebral muscles.
D. Scalenus anterior.
E. Trapezius.
F. Deep muscles on back of neck.
G. Depressor muscles of larynx and hyoid bone.
H. Trachea.
I. Carotid artery and its sheath.
J. External jugular vein.

acromion. Between the two scapulæ it is prolonged downwards to be continuous with the thoracic portion of the lumbodorsal fascia.

The processes given off from the fascia colli lining the deep surface of the sterno-cleido-mastoideus are :—(1) the *prevertebral fascia* from which another thin lamina called the *buccopharyngeal fascia* is given off, (2) the *pretracheal fascia*, (3) the *carotid sheath*, and (4) the *fascia of the omohyoideus*. Besides these processes some thickened bands will be noticed in connection with them. All these processes and thickened bands will be studied later on.

Dissection. The dissector should now clean the sterno-cleido-mastoideus by removing from its surface the thin

layer of the fascia colli and should define its origin and insertion.

The **Sterno-cleido-mastoideus** is broad and thin at either end but narrow and thick at its middle part. It arises by two heads, one from the sternum and the other from the clavicle. The *sternal head* arises from the upper part of the anterior surface of the manubrium sterni by a thick rounded tendon. The *clavicular head* arises from the superior border and anterior surface of the medial third of the clavicle by fleshy and aponeurotic fibres. The two heads remain separated from each other by an oblique cleft below, but at about half way up the neck they unite into a thick muscle which ascends to be inserted by a tendon into the outer surface of the mastoid process and by an aponeurosis into the lateral half of the superior nuchal line of the occipital bone. It is supplied by the accessory nerve which pierces it and by the anterior divisions of the second and third cervical nerves. *Actions.*—If both the muscles act together they bend the cervical part of the vertebral column; when one muscle acts, it turns the head towards the shoulder on the same side.

Dissection. The dissection of the posterior triangle of the neck should now engage the attention of the student. The head is to be turned to the opposite side and fixed by hooks and the shoulder is to be depressed. As this position interferes with the dissection of the axilla, the dissector of the head and neck should stop work when the dissector of the axilla works and vice versa. The layer of fascia colli which stretches between the anterior margin of the trapezius and the posterior margin of the sterno-cleido-mastoideus is to be removed—and this task should be done cautiously to avoid injury to the underlying vessels and nerves. Look for the inferior belly of the omohyoideus which crosses the triangle obliquely about an inch above the clavicle. Next note that a process from the fascia colli lying behind the sterno-cleido-mastoideus descends to enclose the tendon of the omohyoideus and becomes attached to the posterior border of the clavicle. The nerve twig (from the ansa hypoglossi) lying under cover of the sterno-cleido-mastoideus and entering the inferior belly of the omohyoideus is to be secured. Note also the presence of a number of lymph glands; these are placed along the posterior margin of the sterno-cleido-mastoideus over the cervical nerves and their branches. Above the omohyoideus are seen the accessory nerve and the branches

of the cervical plexus ; the former will be recognised by its pierc-ing the sterno-cleido-mastoideus ; the superficial branches of the latter (described on p. 250) should now be traced to their origin. The cervical nerves which supply the trapezius and levator scapulæ should also be secured. Another process of the fascia colli originating from the layer which lies behind the sterno-cleido-mastoideus will be seen passing downwards covering the subclavian vessels and the brachial plexus of nerves. This is continuous with the prevertebral fascia in the anterior triangle of the neck. This layer is to be removed. Below the omohyoideus seek the brachial plexus and the subclavian artery. The former should be dissected out together with its branches given off above the clavicle. The slender nerve supplying the subclavius muscle which descends vertically from the trunk formed by the fifth and sixth cervical nerves is to be secured. And lastly, the transverse cervical artery will be found as it emerges from under cover of the omohyoideus and passes upwards and backwards ; and the transverse scapular artery, behind the clavicle.

The **Posterior Triangle** (Fig. 80) is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus ; behind by the anterior margin of the trapezius ; its base is formed by the middle third of the clavicle ; and its apex corresponds to the meeting of the sterno-cleido-mastoideus and the trapezius or the superior nuchal line of the occipital bone when these two muscles do not meet. It is subdivided by the inferior belly of the omohyoideus into two unequal triangles—an upper, larger triangle, called the occipital triangle ; and a lower, smaller triangle, called the subclavian triangle.

The **Occipital Triangle** is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus ; behind by the anterior margin of the trapezius ; and below by the inferior belly of the omohyoideus. Its *floor* is formed from above downwards by the splenius capitis, the levator scapulæ, the scaleni medius and posterior, and sometimes a small part of the semispinalis capitis which is seen above.

The *contents* of the triangle are :—

I. Vessels $\left\{ \right.$
1. The occipital artery (when the sterno-cleido-mastoideus and the trape-zius do not meet at the occiput).
2. Transverse cervical artery and vein.

II. Nerves

1. The accessory nerve.
2. The upper part of the brachial plexus.
3. The superficial branches of the cervical plexus.
4. Branches from the third and fourth cervical nerves which supply the trapezius.
5. Branches from the third and fourth cervical nerves which supply the levator scapulæ and scalenus medius.

III. Inferior deep cervical lymph glands lying along the posterior margin of the sterno-cleido-mastoideus.

The **Subclavian Triangle** is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus which constitutes its base; below by the middle third of the clavicle; and above by the inferior belly of the omohyoideus. It varies much in size; thus the size of the space is much reduced (1) in muscular subjects owing to the attachments of the sterno-cleido-mastoideus and the trapezius to the clavicle approaching each other; (2) if the inferior belly of the omohyoideus runs close to the clavicle. The *floor* is formed by a portion of the first rib and the first digitation of the serratus anterior.

The *contents* of the subclavian triangle are:—

(1) The third part of the subclavian artery and the subclavian vein.

(2) Transverse scapular artery and vein.

(3) Transverse cervical artery and vein.

(4) Terminal part of the external jugular vein.

(5) The trunks of the brachial plexus with their branches given off above the clavicle.

(6) Inferior deep cervical lymph glands, lying along the posterior margin of the sterno-cleido-mastoideus.

Subclavian Artery.—The third portion of the subclavian artery is seen in the subclavian triangle. This portion extends from the lateral margin of the scalenus anterior to the outer border of the first rib where it becomes the axillary artery. No branch is usually given off from this portion of the artery. It should be noted that this portion is most superficial and consequently the artery is ligatured here when the surgeon has a choice. The relations of this part of the vessel are therefore a matter of great importance and may be tabulated as follows:—

(I) Relations to fasciæ, muscles and bones :—

The superficial fascia, the platysma, the deep cervical fascia, the clavicle and the subclavius muscle lie *in front* of it. It lies against the first rib and the scalenus medius muscle.

(II) Relations to arteries, veins and nerves :—

Arteries	Transverse cervical Transverse scapular	cross from medial to lateral side.
Veins	Transverse cervical Transverse scapular	cross from lateral to medial side.
	External jugular ..	crosses from above downwards.
	Subclavian ..	lies below and in front.
Nerves	Trunks of brachial plexus	upper two trunks lie above; lower trunk behind.
	Nerve to subclavius	crosses from above downwards.
	Supraclavicular nerves	cross from above downwards.

The **Transverse Cervical Artery** is one of the branches of the thyreo-cervical trunk. It passes lateralwards over the scalenus anterior and phrenic nerve under cover of the sterno-cleido-mastoideus. It then proceeds behind the omohyoideus, crossing the brachial plexus of nerves, and runs laterally above that muscle. Reaching the trapezius it passes beneath its anterior margin where it divides into ascending and descending branches (p. 222). Its *companion vein* opens into the external jugular veins.

The **Tranverse Scapular Artery** (Suprascapular artery) arises from the thyreo-cervical trunk and occupies a lower level than the preceding artery. It passes lateralwards over the scalenus anterior and phrenic nerve under cover of the sterno-cleido-mastoideus. It then passes in front of the third portion of the subclavian artery and the cords of the brachial plexus and proceeds under cover of the clavicle and the inferior belly of the omohyoideus. Next it passes beneath the trapezius towards the upper border of the scapula. It will be traced again during the dissection of the superior extremity. The *companion vein* opens into the external jugular vein.

External Jugular Vein.—Its terminal part should now be examined. It opens into the subclavian vein and is provided with a pair of valves at its entrance. Near its termination it receives the anterior jugular vein medially and the transverse cervical and transverse scapular veins laterally.

Dissection. The upper part of the brachial plexus lies in the neck and its lower part in the axilla. This plexus should therefore be studied in conjunction with the dissector of the superior extremity. If the dissection of the axilla has been completed, the middle third of the clavicle is to be removed with a saw detaching the subclavius muscle from its under surface. Divide this muscle at its attachment laterally, to the portion of the clavicle still intact, and reflect it medially together with its nerve· Display the whole extent of the brachial plexus and trace the branches proceeding from it.

The **Brachial Plexus** is formed by the anterior divisions of the fifth, sixth, seventh and eighth cervical nerves and the greater part of the anterior division of the first thoracic nerve. Usually a branch from the fourth cervical nerve joins the fifth cervical and not infrequently a branch from the second thoracic communicates with the first thoracic nerve. These nerves constitute the *roots* of the plexus and lie between the scaleni anterior and medius. Three *trunks* are then formed by the union of these roots : thus the fifth and sixth cervical nerves unite to form a a trunk called the *upper trunk ;* the seventh cervical remains alone forming the *middle trunk ;* while the eighth cervical and the branch from the first thoracic unite to form the *lower trunk.* The upper and middle trunks lie above the subclavian artery whilst the lower trunk lies behind it. Each of the three trunks formed in this way divides behind the clavicle into an *anterior* and a *posterior division.* These divisions lie on the lateral side of the first part of the axillary artery. The anterior divisions of the upper and middle trunks unite to form the *lateral cord.* The anterior division of the lower trunk remains alone forming the *medial cord* whilst the posterior divisions of all the three trunks unite to form the *posterior cord.* The lateral, medial and posterior cords occupy the corresponding sides of the second part of the axillary artery. The following table shows at a glance the formation of the brachial plexus :—

Roots	5th and 6th C.Ns.=Upper trunk=Ant. dvn.	Lateral cord	and Post. dvn.	Posterior cord
	7th C.N.=Middle trunk=Ant. dvn.		and Post. dvn	
	8th C.N. and 1st Th.N.=Lower trunk=Ant. dvn.	Medial cord	and Post. dvn.	

Relations of the Plexus.—The plexus lies (1) in the lower part

of the posterior triangle of the neck; (2) behind the middle third of the clavicle; and (3) in the axilla. *In the neck,* the plexus is covered by the fascia colli and is crossed by the supraclavicular

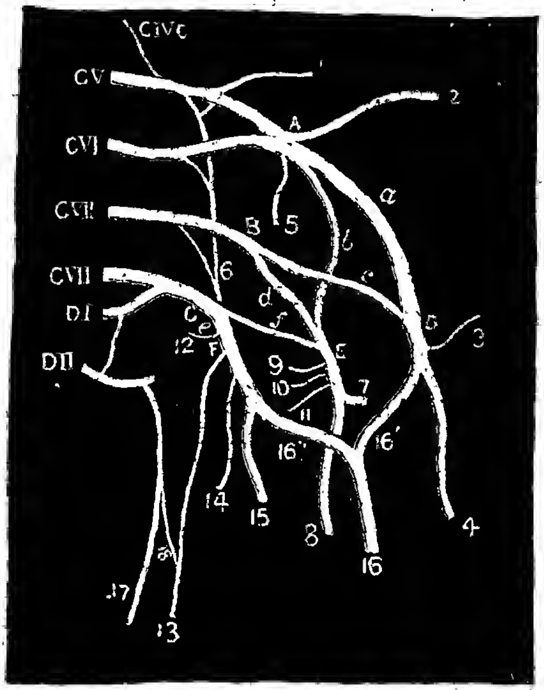


Fig. 82.—Diagram of the brachial plexus of nerves.

CIVC. Communicating branch from the fourth cervical nerve.
CV, CVI, CVII, CVIII, DI, DII. Anterior primary divisions of the fifth, sixth, seventh, eighth, first and second thoracic nerves.
A. Upper trunk dividing into *a, b,* anterior and posterior divisions.
B. Middle trunk dividing into *c, d,* anterior and posterior divisions.
C. Lower trunk dividing into *e, f,* anterior and posterior divisions.
D. Lateral cord.
E. Posterior cord.
F. Medial cord.
1. Dorsal scapular nerve.
2. Suprascapular nerve.
3. Lateral anterior thoracic nerve.
4. Musculo-cutaneous nerve.
5. Nerve to subclavius.
6. Long thoracic nerve.
7. Axillary nerve.
8. Radial nerve.
9. 11. Upper and lower subscapular nerves.
10. Thoracodorsal nerve.
12. Medial anterior thoracic nerve.
13. Medial brachial cutaneous nerve.
14. Medial antibrachial cutaneous nerve.
15. Ulnar nerve.
16. Median nerve.
16′. Lateral head of median nerve.
16″. Medial head of median nerve.
17. Intercosto-brachial nerve.
18. Communicating twig from the intercosto-brachial nerve to the medial brachial cutaneous nerve.

nerves, the external jugular vein, the transverse cervical vessels and the inferior belly of the omohyoideus. The scalenus medius lies behind it.

The **Branches of the Brachial Plexus** can be divided into two sets, viz., those which arise *above* the clavicle and those *below* that bone. The branches given off above the clavicle are called the supraclavicular branches and belong to the dissector of the head and neck. The branches given off below the clavicle, called the *infraclavicular branches*, belong to the dissector of the superior extremity and will be described with that part. The *supraclavicular branches* are :—(1) The *communicating branch to the phrenic nerve*. It is derived from the fifth cervical nerve and joins the phrenic nerve on the scalenus anterior muscle. (2) The *muscular branches* to the scaleni and longus colli are derived from the lower four cervical nerves soon after their exit from the intervertebral foramina. (3) The *dorsal scapular nerve* (nerve to Rhomboidei) arises from the fifth cervical nerve, pierces the scalenus medius and passes beneath the levator scapulæ accompanied by the descending branch of the transverse cervical artery and supplies the rhomboidei. This nerve occasionally supplies a twig to the levator scapulæ. (4) The *nerve to the subclavius* is a slender twig which arises from the upper trunk of the plexus formed by the union of the fifth and sixth cervical nerves and descends in front of the third part of the subclavian artery to supply the subclavius. (5) The *suprascapular nerve* arises from the upper trunk of the brachial plexus, passes downwards and lateralwards beneath the omohyoideus and the trapezius and enters the supraspinous fossa by passing through the suprascapular notch. (6) The *long thoracic nerve* (Posterior thoracic or external respiratory nerve of Bell) arises by three roots from the fifth, sixth and seventh cervical nerves. The roots from the fifth and sixth cervical nerves pierce the scalenus medius and that from the seventh cervical nerve passes in front of the muscle. The nerve runs downwards behind the brachial plexus and the axillary vessels and lies against the outer surface of the serratus anterior supplying twigs to each of its digitations.

The *inferior deep cervical lymph glands* are seen in the subclavian triangle closely related to the subclavian vein and the trunks of the brachial plexus. They receive afferents from the superior deep cervical lymph glands and usually some from the subclavicular group of lymph glands. Their efferents form a lymph trunk, the *jugular trunk*, which opens into the junction

of the internal jugular vein and the subclavian vein on the right side and into the thoracic duct on the left side.

The **Accessory Nerve** (Spinal accessory nerve) appears at the upper part of the occipital triangle by piercing the sterno-cleido-mastoideus to which it supplies some filaments. It then crosses the triangle obliquely downwards, lateralwards and backwards and enters the deep surface of the trapezius.

Branches from the third and fourth cervical nerves to the trapezius.—These two branches also cross the posterior triangle below the accessory nerve obliquely downwards, lateralwards and backwards and enter the deep surface of the trapezius. They communicate with the accessory nerve. *Branches from the third and fourth cervical nerves to the levator scapulæ.*—These are minute twigs entering the levator scapulæ near its origin.

In the occipital triangle, some *lymph glands* are found at the posterior margin of the sterno-cleido-mastoideus. Their efferents pass to the inferior deep cervical lymph glands.

The dissector of the superior extremity removes the limb from the trunk at this stage and for this he divides the blood vessels and nerves at the outer border of the first rib.

THE FACE

The dissector of the head and neck should now proceed to dissect the face as satisfactory dissection can be done only before it is dried up. The dissection of the anterior triangle will be taken up later on.

Before commencing the dissection of the face the student should examine the various parts of the external ear and the appendages of the eye.

External Ear.—The ear (organ of hearing) is divisible into three portions : the external ear, the middle ear and the internal ear. The external ear consists of (1) a fibrocartilaginous expanded portion covered with skin, called the pinna or auricula and (2) the external acoustic meatus.

Auricula or Pinna.—Different names have been given to the various parts of the pinna. The folded margin of the pinna is called the *helix*. In front of the helix and separated from it by a curved depression, called the *scapha* (fossa of the helix), is another curved prominence called the *antihelix*. The antihelix bifurcates at its upper extremity, presenting a triangular depression between the two diverging limbs called

the *fossa triangularis* (fossa of the antihelix). The broad deep cavity bounded posteriorly by the antihelix is called the *concha.*

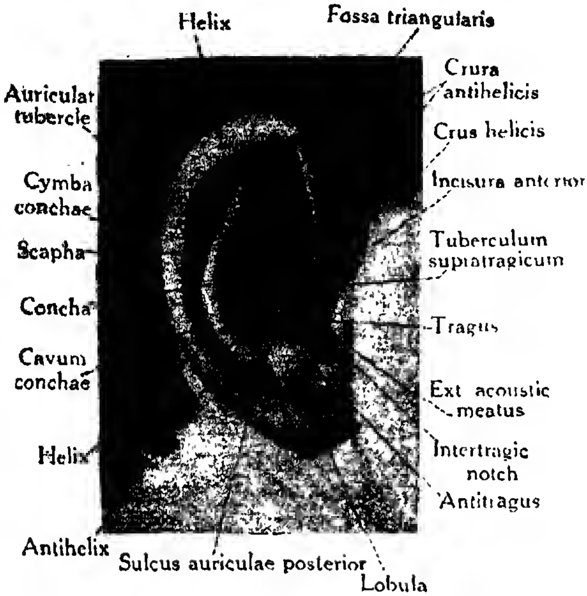


Fig. 83.—The auricula (Sobotta).

The concha is partially subdivided by the *crus* or anterior end of the helix into an upper part called the *cymba conchæ* and a lower part called the *cavum conchæ.* The conical projection in front of the concha and projecting backwards over the external acoustic meatus is called the *tragus.* Behind the tragus and separated from it by a notch (*intertragic notch*) is another nodule called the *antitragus.* The lowest soft dependent part of the ear is called the *lobule.*

The *external acoustic meatus* is a canal which extends from the bottom of the concha to the tympanic membrane and is about one inch and a quarter (3 cm.) in length. It consists of a medial bony portion and a lateral cartilaginous portion. The latter is a tubular prolongation from the pinna itself fixed to the lateral margin of the bony external acoustic meatus.

Dissection. Remove the skin carefully from the auricula. The cartilage, the ligaments, and the intrinsic muscles of the auricula are now exposed.

The cartilage of the auricula extends over the whole auricula

as one piece but is absent from the lobule. The helix at the posterior margin of the auricula is prolonged downwards as a tail-like process called the *cauda helicis.* Between this and the antihelix is a fissure called the *fissura antitragohelicina.* A small eminence, called the *spina helicis,* is seen where the helix bends upwards in front. Between the tragus and the helix is a gap in the cartilage which is filled up by dense fibrous tissue. The auricular cartilage is prolonged from the bottom of the concha as a tubular process which is fixed to the margin of the porus acusticus externus of the temporal bone. This forms the cartilaginous portion of the external acoustic meatus. The cartilaginous tube is incomplete being deficient above and posteriorly, the gap being filled up by dense fibrous tissue.

Ligaments of the auricula.—There are three extrinsic ligaments. The *anterior* passes from the spina helicis to the root of the zygomatic process of the temporal bone. The *superior* extends from the concha to the temporal fascia. The *posterior* extends from the concha to the outer surface of the mastoid process. There are also several intrinsic ligaments connecting the various parts of the auricular cartilage.

The *intrinsic muscles* of the ear are :—(1) The *helicis major* which arises from the spina helicis and is inserted into the anterior margin of the helix. (2) The *helicis minor* covers the lateral surface of the crus helicis. (3) The *tragicus* consists of vertical fibres on the lateral surface of the tragus. (4) The *antitragicus* arises from the lateral surface of the antitragus and is inserted into the antihelix and cauda helicis. (5) The *transversus auriculæ* lies on the cranial surface of the auricula and extends from the prominence of the concha to the prominence of the helix. (6) The *obliquus auriculæ,* also on the cranial surface, extends from the prominence of the concha to the eminentia triangularis, opposite the fossa triangularis. These muscles are supplied by the facial nerve.

Accessory organs of the Eye.—These consist of the eyebrows, the eyelids, the conjunctiva, the lacrimal apparatus and the ocular muscles.

The *eyebrows* are two curved eminences of the skin placed over the upper margin of the orbit and covered with short stiff hairs. The *eyelids* are two crescentic folds which cover and protect each eyeball. The upper lid is larger and more movable than the lower one. When the eye is open an elliptical interval between the eyelids is seen called the *palpebral fissure.* When

the eyelids are closed the fissure is reduced to a transverse slit. The two eyelids meet at the extremities of the palpebral fissure and form the medial and lateral *palpebral commissures* or *canthi*. At the medial canthus the two eyelids are separated from each other by a triangular interval called the *lacus lacrimalis*. To the free margin of each eyelid lateral to the lacus lacrimalis are attached the eyelashes. Behind the attachment of the eyelashes are seen the minute openings of the *ciliary glands*. The margins of the eyelids where they bound the lacus lacrimalis are devoid of eyelashes and ciliary glands and present at their lateral ends an elevation, called the *papilla lacrimalis*, at the summit of which a minute opening is seen, called the *punctum lacrimale*, or the opening of the lacrimal duct (Fig. 88).

The *conjunctiva* is the mucous membrane lining the inner surface of the eyelids and the front of the eyeball; the part which lines the eyelids is called the *palpebral conjunctiva*, while that lining the eyeball, the *ocular conjunctiva*. The line along which the conjunctiva lining the eyelids is reflected on to the eyeball is called the *fornix conjunctivæ*; that from the upper eyelid on to the eyeball is called the *superior fornix* and that from the lower eyelid, the *inferior fornix*. At the centre of the lacus lacrimalis there is a small reddish conical elevation, called the *caruncula lacrimalis* with a few tiny hairs attached to it. On the lateral side of the caruncula lacrimalis is seen a vertical fold of the conjunctiva called the *plica semilunaris*. It is the representative of the membrana nictitans or the third eyelid found in birds and many other animals.

The different strata of the eyelids, the lacrimal apparatus, and the ocular muscles will be examined later.

Dissection. Put a little cotton wool beneath the eyelids so as to make them tense and then stitch their free margins together. Similarly insert a plug of tow into the mouth to make the cheeks and lips tense and then stitch the margins of the lips together. Make a vertical incision just in front of the ear. This incision extends above to the horizontal skin incision for the dissection of the scalp and below it meets the line drawn from the angle of the mandible to the tip of the mastoid process. Reflect the skin towards the middle line. In doing this great care is to be taken, for the subcutaneous tissue between the skin and the pale facial muscles is very scanty in many places and is altogether absent over the eyelids. Take care of the platysma as it passes upwards from the neck to blend with the facial muscles

at the angle of the mouth. Clean the fascia over the parotid gland and the masseter muscle. Look for the anterior branch (facial branch) of the great auricular nerve which supplies the skin over the parotid gland.

The *anterior branch of the great auricular nerve* supplies the skin over the parotid gland and sends twigs through the gland to communicate with the facial nerve.

The *parotideo-masseteric fascia* is the deep fascia of the face. It covers the parotid gland behind and the masseter muscle in front. It is continuous below with the deep fascia of the neck and above it is attached to the zygomatic arch.

Dissection. The muscles of the face are now to be dissected without injuring the cutaneous nerves and blood vessels. Begin with the muscles of the eyelids. Clean the fibres of the orbicularis oculi which form elliptical loops over the eyelids and around the margin of the orbit. Expose the corrugator at the medial end of the superciliary arch under cover of the medial part of frontalis. In cleaning the muscles of the mouth begin with the orbicularis oris surrounding the aperture of the mouth and define the muscles of the upper and lower lips converging towards it. Lastly define the thin muscles of the nose.

The **Muscles of the Face** may be divided into three groups :—(I) Those of the eyelids ; (II) those of the mouth ; and (III) those of the nose.

I. The **Muscles of the Eyelids** are—

(1) The **Orbicularis Oculi** is the sphincter muscle of the eyelids. It consists of three portions, orbital, palpebral and lacrimal. The *orbital portion* is placed around the margin of the orbit : its fibres extending lateralwards over the temple, upwards over the forehead and downwards over the cheek. It consists of elliptical loops which arise (1) from the medial palpebral ligament, (2) from the frontal process of the maxilla, and (3) from the nasal part of the frontal bone. The loops completely encircle the eyelids around the lateral canthus. The *palpebral portion* is placed upon and limited to the eyelids. It arises from the medial palpebral ligament and extends lateralwards upon both the eyelids in the form of concentric curves to be inserted into the lateral palpebral raphe. Close to the free m rgins of the eyelids the loops are thickened to form what is called the *ciliary bundle.* The *lacrimal portion* (tensor tarsi) will be studied during the dissection of the orbit. The muscle is supplied by the facial nerve.

(2) The *levator palpebræ superioris* will be studied during the dissection of the orbit.

(3) The **Corrugator** (corrugator supercilii) is a small muscle which remains covered by the medial part of the orbicularis oculi and the frontalis. It arises from the medial end of the superciliary arch and passes upwards and lateralwards through the fibres of the orbicularis oculi and frontalis to be inserted into the skin of the forehead opposite the middle of the eyebrow. It is supplied by the facial nerve. It draws the eyebrow medialwards and downwards and thus causes vertical wrinkles of the forehead.

II. The **Muscles of the Mouth** are :—

(1) The **Quadratus Labii Superioris** has a broad origin divisible into three heads. The medial or *angular head* (Levator labii superioris alæque nasi) arises from the upper portion of the frontal process of the maxilla, passes downwards and divides into a nasal and a labial slip. The nasal slip is inserted into the alar cartilage and skin of the nose. The labial slip is blended with the orbicularis oris. The intermediate or *infraorbital head* (levator labii superioris) arises from the lower margin of the orbit just above the infraorbital foramen and is inserted into the oribicularis oris and the skin of the upper lip. The lateral or *zygomatic head* (zygomaticus minor) arises from the malar surface

A. Frontalis muscle.
B. Occipitalis muscle.
C. Galea aponeurotica.
D. Orbicularis oculi.
E. Procerus.
F. Nasalis.
G. Orbicularis oris.
H. Quadratus labii superioris (angular head).
I. Its infraorbital head.
J. Its zygomatic head.
K. Zygomaticus.
L. Quadratus labii inferioris.
M. Triangularis.
N. Mentalis.
O. Masseter (superficial portion).
P. Masseter (deep portion).
Q. Auricularis anterior.
R. Buccinator.
S. Auricularis superior.
T. Temporal fascia.
U. Auricularis posterior.
V. Digastric (anterior belly).
W. Stylohyoid pierced by the posterior belly of the digastric.
X. Mylohyoid.
Y. Sterno-cleido-mastoideus.
Z. Trapezius.

Fig. 84.—The muscles of the face.

of the zygomatic bone behind the zygomatico-maxillary suture and passes downwards and medialwards to be inserted into the orbicularis oris and the skin of the upper lip. It is supplied by the buccal branches of the facial nerve. By the action of this muscle the upper lip is raised and also everted.

(2) The **Caninus** (Levator anguli oris) arises from the canine fossa below the infraorbital foramen and lies under cover of the infraorbital head of the quadratus labii superioris which should be detached from its origin and reflected downwards to expose the muscles. It passes downwards and lateralwards to become inserted into the angle of the mouth where its fibres blend with those of the orbicularis oris. It is supplied by the buccal branches of the facial nerve. It elevates the angle of the mouth.

(3) The **Zygomaticus** (Zygomaticus major) arises from the zygomatic bone in front of the zygomatico-temporal suture. It passes downwards and medialwards to become inserted into the angle of the mouth where its fibres blend with those of the caninus, orbicularis and triangularis. It is supplied by the buccal branches of the facial nerve. By its action the angle of the mouth is drawn upwards and lateralwards.

(4) The **Risorius** arises from the parotideo-masseteric fascia and is inserted into the skin at the angle of the mouth mingling with the fibres of the orbicularis oris. It is supplied by the buccal branches of the facial nerve. It retracts the corner of the mouth.

(5) The **Triangularis** (Depressor anguli oris) arises by its broad base from the oblique line of the mandible below and lateral to the origin of the quadratus labii inferioris. It is inserted by its apex into the angle of the mouth, where its fibres blend with those of the orbicularis oris and the risorius. It is supplied by the mandibular branch of the facial nerve. It draws the angle of the mouth downwards.

Dissection. Divide the triangularis at its origin and reflect it upwards. The quadratus labii inferioris is now exposed.

(6) The **Quadratus Labii Inferioris** (Depressor labii inferioris) arises from the oblique line of the mandible between the symphysis menti and the mental foramen above the origin of the triangularis. The fibres pass upwards and medialwards, blend with those of the orbicularis oris and are inserted into the skin of the lower lip. It is supplied by the mandibular branch of the facial nerve. By its action the lower lip is drawn downwards and everted.

Dissection. Divide the quadratus labii inferioris at its origin and reflect it upwards.

(7) The **Orbicularis Oris** surrounds the oral aperture and serves as its sphincter muscle. Its fibres are derived partly from the continuation into the lips of the fibres of the buccinator, the caninus and the triangularis. The fibres from the caninus pass along the angle of the mouth to the lower lip and those of the triangularis into the upper lip. The fibres of the buccinator pass into both the lips. Some fibres are also derived from the other facial muscles passing into the lips. Besides these fibres there are additional bands in the upper and lower lips. Thus on each side of the middle line in the upper lip there are two bands, (1) the medial band or the *musculus nasolabialis* attached above to the back part of the nasal septum, (2) the lateral band or the *musculus incisivus labii superioris* attached to the alveolar border of the maxilla corresponding to the lateral incisor tooth. On each side of the middle line in the lower lip there is a band, called the *musculus incisivus labii inferioris*, which is attached below to the alveolar border of the mandible corresponding to the lateral incisor tooth. The muscle is supplied by the buccal and mandibular branches of the facial nerve. It brings the lips together, so as to close the oral aperture and it causes the free edges of the lips to protrude. It compresses the lips against the teeth and turns their margins inwards.

Dissection. Divide the zygomaticus and risorius at their origin and reflect them towards the mouth. Note that the buccinator is covered by a layer of fascia, the *buccopharyngeal fascia ;* on its superficial surface but posteriorly there is a pad of fat, *suctorial pad*, so called because it helps in the act of sucking. One or two lymph glands, called the *buccal lymph glands*, may be seen on the superficial surface of the muscle. Four or five glands, called the *molar salivary glands*, are found in the suctorial pad around the distal end of the parotid duct. The minute ducts of these glands pass through the buccinator and open into the buccal cavity. Remove the suctorial pad and bucco-pharyngeal fascia and clean the surface of the buccinator without injuring the parotid duct or the nerve filaments derived from the buccinator nerve and the buccal branches of the facial nerve.

(8) The **Buccinator** arises from the outer surfaces of the alveolar processes of the maxilla and the mandible as far forwards as the first molar tooth. Behind, it arises from the pterygo-mandibular raphe which extends from the hamulus of the medial

pterygoid lamina to the back part of the mylohyoid line. This raphe separates it from the superior constrictor of the pharynx. At the angle of the mouth the upper fibres pass into the upper lip and the lower fibres into the lower lip but the intermediate fibres decussate so that the upper fibres pass into the lower lip and the lower fibres into the upper lip. The parotid duct pierces the muscle opposite the second molar tooth of the maxilla. The deep surface of the muscle lies in relation with the mucous membrane of the mouth and with some small *buccal salivary lymph glands*. It is supplied by the buccal branches of the facial nerve. The muscle is used during mastication when the food is subjected to the action of the teeth. It is also used for the expulsion of air from the mouth as in whistling and blowing.

(9) The **Mentalis** (Levator labii inferioris or levator menti) arises from the incisive fossa of the mandible and passes downwards to be inserted into the skin of the chin. It is supplied by the mandibular branch of the facial nerve It raises the lower lip.

III. The **Muscles of the Nose** are :—

(1) The **Procerus** (Pyramidalis nasi) arises by its broad base from the fascia covering the lower part of the nasal bones and the adjoining part of the lateral nasal cartilage. It is inserted by its narrow end into the skin over the glabella ; some of its fibres intermingling with those of the frontalis. It is supplied by the buccal branches of the facial nerve. It draws down the skin of the centre of the forehead and produces transverse wrinkles over the bridge of the nose.

(2) The **Nasalis** (Compressor naris) consists of two parts, transverse and alar. The *transverse part* arises from the maxilla above and lateral to the incisive fossa and passes upwards and medialwards across the cartilaginous part of the lateral wall of the nose to end in an aponeurosis. This aponeurosis is continuous with that of the opposite side over the bridge of the nose and from it the procerus takes its origin. The *alar part* arises from the greater alar cartilage of the nose and is inserted into the skin at the tip of the nose. The nasalis is supplied by the buccal branches of the facial nerve. It depresses the tip of the nose.

(3) The **Depressor Septi** arises from the incisive fossa of the maxilla and passes upwards and forwards to be inserted into the lower and back part of the septum and ala of the nose. It is supplied by the buccal branches of the facial nerve. It

depresses the nasal septum and constricts the anterior nasal aperture.

(4) The **Dilatator Naris Posterior** arises from the lateral margin of the nasal notch of the maxilla and is inserted into the skin at the margin of the nostril.

(5) The **Dilatator Naris Anterior** is a thin fasciculus situated in front of the preceding muscle. It arises from the greater alar cartilage and is inserted into the skin at the margin of the nostril. The dilatatores naris are supplied by the buccal branches of the facial nerve. They enlarge the nasal aperture.

The dissector should now study the parotid gland and its duct after removal of the deep fascia covering its surface.

The **Parotid Gland** (Figs. 85, 86) is the largest of the salivary glands. It is placed on the side of the face below and in front of the external ear. It is limited above by the zygomatic arch; below by a line drawn from the angle of the mandible to the tip of the mastoid process; behind by the anterior border of the mastoid process and the sterno-cleido-mastoid muscle; in front it lies against the posterior border of the masseter and the ramus of the mandible and is continued for a variable distance over the surface of the masseter. Not unfrequently a small detached portion of the gland, the *accessory parotid gland* (socia parotidis) is seen upon the masseter muscle below the zygomatic arch. Between the posterior border of the ramus of the mandible and the posterior border of the internal pterygoid muscle a part of the gland passes forwards and is called the *pterygoid lobe*

Relations.—The *superficial surface* of the gland is covered by the skin, the superficial fascia and the deep fascia (parotideo-masseteric fascia) with some parotid lymph glands. Its *deep surface* is in relation with the styloid process together with the muscles attached to it; the glossopharyngeal and vagus nerves and the great vessels at the upper part of the neck, viz., the internal and external carotid arteries and the internal jugular vein, lie in contact with it Its *anterior surface* lies on the posterior border of the ramus of the mandible and on the posterior borders of the masseter and pterygoideus internus. Its *posterior surface* lies over the external acoustic meatus, the mastoid process and the anterior margin of the sterno-cleido-mastoideus.

Structures traversing the gland.—(1) The external carotid artery passes through the substance of the gland and furnishes the posterior auricular branch which leaves the gland at its

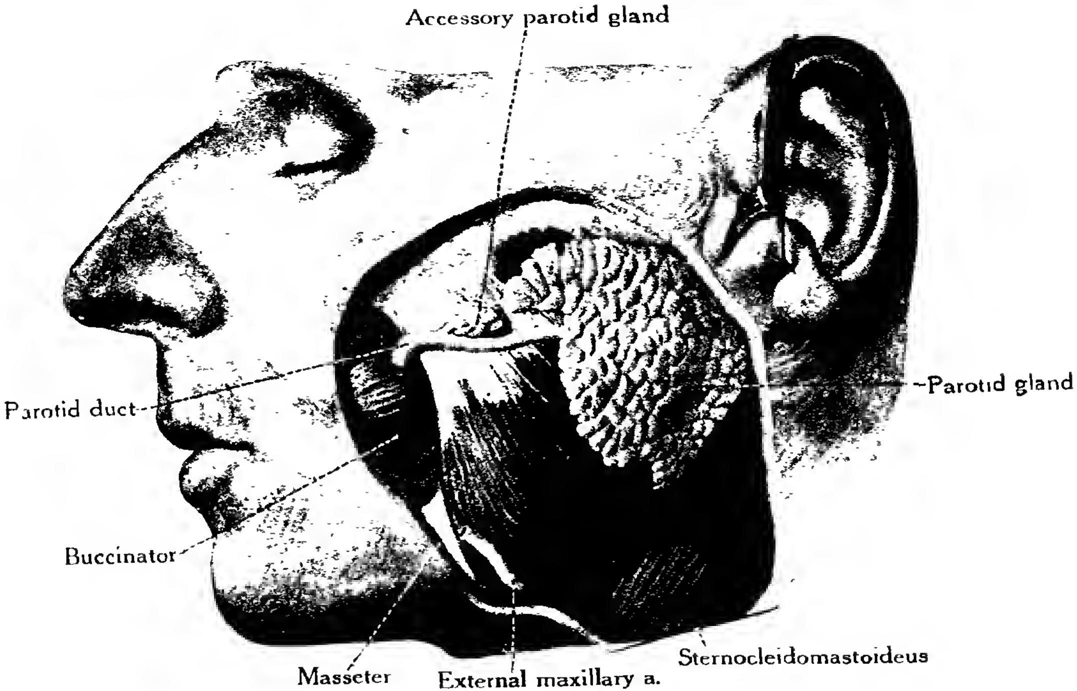


Fig 85.—The superficial surface of the parotid gland (Sobotta).

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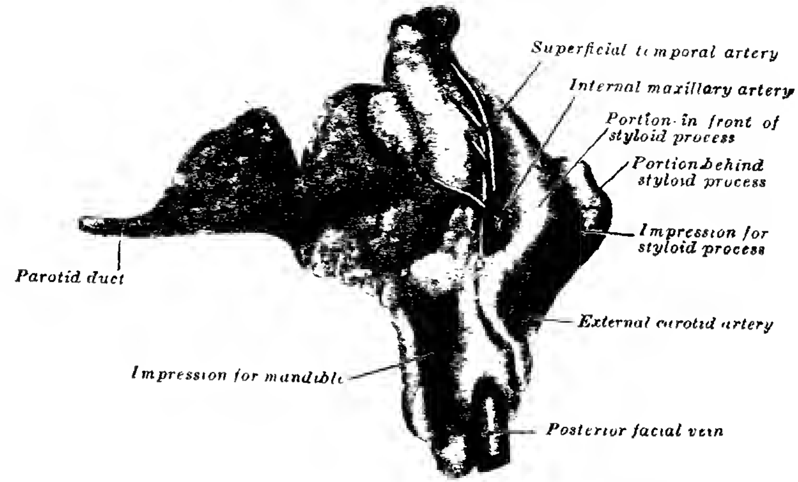

Fig. 86 —The medial aspect of the parotid gland (Gray).

posterior margin ; the artery then gives off its two terminal branches, the superficial temporal and internal maxillary arteries —the former passes upwards and furnishes the transverse facial branch which leaves the gland at its anterior margin ; the latter proceeds forwards to reach the neck of the mandible. (2) The venous trunk, called the posterior facial vein, is formed by the union of the superficial temporal and internal maxillary veins and these three veins are placed superficially to the arteries ; the trunk then divides into an anterior and a posterior division—the former emerges from the gland and then unites with anterior facial vein ; but the latter unites with the posterior auricular vein in the substance of the gland. (3) The facial nerve, more superficially placed, crosses the vessels from behind forwards and gives off branches here which emerge from the borders of the gland. (4) The auriculo-temporal nerve, which accompanies the superficial temporal artery, emerges from the upper part of the gland. (5) Offsets of the great auricular nerve pierce the gland at its lower part and join the facial nerve.

The **Parotid Duct** (Stensen's duct) begins by numerous branches from the gland and appears at the anterior border of the gland. It runs forwards below the zygomatic arch and across the masseter muscle and, reaching the anterior border of that muscle, dips inwards and perforates the buccinator muscle. Then it passes obliquely forwards between the buccinator and the mucous membrane of the mouth and opens into the mouth by a small orifice on a papilla opposite the second molar tooth of the upper jaw. While crossing the masseter muscle it receives the duct of the accessory part of the gland. The duct is about two inches (5 cm.) long and its lumen admits the passage of a small probe.

Dissection. Remove the parotid gland piecemeal and at the same time trace cautiously the structures which traverse it. Trace the branches of the facial nerve backwards through the substance of the gland until they join the parent nerve or its two main divisions. Its temporal branches will be seen to pass upwards and cross the zygomatic arch. Trace the zygomatic branches which pass forwards above the parotid duct towards the lateral angle of the orbit. Follow the filaments which pass towards the infraorbital foramen and form a plexus with the infraorbital nerve issuing out of the foramen. Follow the buccal branches of the nerve which pass forwards below the parotid duct to the surface of the buccinator muscle. Note that some

filaments ascend to join the infraorbital plexus under cover of the quadratus labii superioris. Trace the mandibular branch and note that it supplies the muscles of the lower lip and communicates with the mental branch of the inferior alveolar nerve which issues out of the mental foramen. Trace the branches of the infraorbital nerve to the lower eyelid, the nose and the upper lip. Trace the *external carotid* artery and its three branches viz., the posterior auricular, internal maxillary and the superficial temporal in the substance of the gland. Trace the superficial temporal artery with its branches as it passes upwards to the temporal region in front of the ear. Clean the external maxillary artery as it passes over the buccinator and caninus muscles to the medial angle of the orbit where it terminates in the angular artery. Trace its superior and inferior labial branches given off near the angle of the mouth; the former passes along the upper lip and the latter along the lower lip. Look for the lateral nasal branch by the side of the ala of the nose. Dissect out all the veins traversing the gland and these have been described. Lastly verify the deep relations of the gland and the deep layer of the fascia colli which passes beneath the gland.

Vessels of the Face (Fig. 67).—These are (1) the superficial temporal artery and its branches, (2) the external maxillary artery and its branches, (3) the superficial temporal vein, and (4) the anterior facial vein.

The **Superficial Temporal Artery** is one of the terminal branches of the external carotid artery. It begins opposite the neck of the mandible in the substance of the parotid gland and runs upwards between the external acoustic meatus and the condyle of the mandible. Crossing the posterior root of the zygomatic arch it ascends upon the temporal fascia and divides into two terminal branches, the frontal and parietal. *Branches.*—(1) The *parotid branches* are minute twigs which supply the parotid gland. (2) The *transverse facial artery* arises in the substance of the parotid gland and runs horizontally forwards across the masseter muscle above the parotid duct and below the zygomatic arch. It divides into branches which supply the parotid gland and the masseter and anastomose with the external maxillary, infraorbital, masseteric and buccinator arteries. (3) The *anterior auricular branches* supply the anterior part of the pinna and the lobule of the ear. (4) The *middle temporal artery* arises above the zygomatic arch and piercing the temporal fascia, supplies

the temporalis muscle and anastomoses with the deep temporal branches of the internal maxillary artery. (5) The *zygomatico-orbital artery* passes forwards above the zygomatic arch between the two layers of the temporal fascia to the lateral angle of the orbit, supplies the orbicularis oculi and anastomoses with the lacrimal and palpebral branches of the ophthalmic artery. (6,7) The *frontal* and *parietal branches* have been studied during the dissection of the scalp.

The *superficial temporal vein* receives tributaries corresponding to the branches of the superficial temporal artery and unites with the internal maxillary vein to form the posterior facial vein. The *posterior facial vein* descends through the substance of the parotid gland and divides into two branches, an anterior and a posterior. The posterior branch unites with the posterior auricular vein to form the external jugular vein. The anterior branch unites with the anterior facial vein to form the *common facial vein.*

External Maxillary Artery (Facial artery).—This artery springs from the external carotid in the neck and presents a cervical and a facial portion. The facial portion is now seen. It is extremely tortuous in its course. It appears on the face by crossing the body of the mandible at the antero-inferior angle of the masseter muscle It then runs forwards and upwards to a point a little behind the angle of the mouth. Then it ascends to the medial palpebral commissure and terminates as the angular artery. It rests successively upon the mandible, the buccinator and the caninus. It is covered by the platysma, the risorius, the zygomaticus and the quadratus labii superioris. *Branches.*—(1) *Posterior set of branches.*—These are small branches which pass backwards to supply the masseteric and buccal regions. (2) The *inferior labial artery* (inferior coronary) arises below the angle of the mouth, passes forwards beneath the triangularis and then along the margin of the lower lip and supplies the muscles and skin of the lower lip. It anastomoses along the middle line with its fellow of the opposite side and with the mental branch of the inferior alveolar artery. (3) The *superior labial artery* (superior coronary artery) arises just above the preceding and passes medialwards along the upper lip between the orbicularis oris and the mucous membrane. It anastomoses with the artery of the opposite side and gives off the *septal artery* which ramifies on the septum of the nose and supplies it as far as the tip of the nose. (4) The *lateral nasal artery* arises from the external

maxillary artery when the parent trunk ascends along the side of the nose. It supplies the ala and the dorsum of the nose and anastomoses with its fellow of the opposite side and with the dorsal nasal branch of the ophthalmic artery. (5) The *angular artery* is the terminal portion of the external maxillary artery. It ascends through the angular head of the quadratus labii superioris and terminates at the medial palpebral commissure by anastomosing with the dorsal nasal branch of the ophthalmic artery.

The **Anterior Facial Vein** (Facial vein) begins at the medial palpebral commissure as the angular vein, passes downwards and backwards to the body of the mandible with a less tortuous course than its companion artery, and lies behind the artery. It receives tributaries corresponding to the branches of the external maxillary artery and at its commencement receives the frontal and supraorbital veins. Over the buccinator muscle it receives the deep facial vein from the pterygoid venous plexus in the infratemporal region. Crossing the body of the mandible it pierces the deep fascia of the neck and appears in the submaxillary triangle. It unites with the anterior division of the posterior facial vein to form the common facial vein. This will be seen during the dissection of the anterior triangle of the neck.

The **Facial Nerve** (Fig. 67) gives off the following terminal branches in the substance of the parotid gland :—(1) The *temporal branches* emerge from the upper border of the parotid gland and cross the zygomatic arch to gain the temporal region of the scalp. Their distribution has been noted (p. 200). (2) The *zygomatic branches* emerge from the anterior border of the parotid gland and pass forwards above the parotid duct and across the zygomatic bone to the lateral angle of the orbit. They supply the orbicularis oculi and communicate with the lacrimal nerve and the zygomatico-facial branch of the maxillary nerve. The lowest branch unites with filaments from the buccal branches and the infraorbital nerve to form the *infraorbital plexus*. (3) The *buccal branches* emerge from the anterior border of the parotid gland and pass forwards below the parotid duct towards the angle of the mouth. The upper branches ascend beneath the zygomaticus and the quadratus labii superioris and form a plexus (*infraorbital plexus*) beneath the latter muscle with the infraorbital branch of the maxillary nerve and with the zygomatic branch of the facial nerve. These branches and filaments from the plexus supply the muscles of the nose and the muscles of the upper lip.

The lower branches supply the buccinator and the orbicularis oris and communicate with the buccinator branch of the mandibular nerve on the buccinator muscle. (4) The *mandibular branch* (inframaxillary branch) emerges from the anterior border of the parotid gland, passes forwards and downwards beneath the triangularis and supplies the muscles of the lower lip and chin. Beneath the triangularis it communicates with the mental branch of the inferior alveolar nerve. (5) The *cervical branch* emerges from the lower border of the parotid gland; its distribution to the platysma has been seen during the superficial dissection of the anterior triangle of the neck.

Sensory Nerves of the Face (Fig. 67).—The *anterior branch of the great auricular nerve*, the *supraorbital* and the *supratrochlear nerves* have already been examined. The *external nasal branch* (nasal nerve) is the terminal branch of the nasociliary nerve. It appears on the nose beneath the nasalis between the lower border of the nasal bone and the lateral nasal cartilage. It supplies the skin of the ala and the tip of the nose. The *infratrochlear nerve* is seen above the medial palpebral ligament. It is a branch of the nasociliary nerve and supplies the skin of the eyelids and the root of the nose. The *terminal branch of the lacrimal nerve* appears at the lateral part of the upper eyelid and supplies the skin of that part. The *infraorbital nerve* is the terminal part of the maxillary nerve. It emerges from the infraorbital foramen with the infraorbital vessels covered by the quadratus labii superioris. It immediately divides into inferior palpebral, external nasal, and superior labial branches. The *inferior palpebral branches* ascend and supply the skin and conjunctiva of the lower eyelid. The *external nasal branches* supply the skin of the side of the nose. The *superior labial branches* supply the skin and mucous membrane of the upper lip and communicate with the zygomatic and buccal branches of the facial nerve forming the infraorbital plexus. The *zygomatico-temporal nerve* has been examined during the dissection of the temporal region of the scalp. The *zygomatico-facial nerve* (malar branch of the temporomalar nerve) emerges through a foramen in the zygomatic bone, pierces the orbicularis oculi, supplies the skin over the zygomatic bone and communicates with the zygomatic branches of the facial nerve. The *buccinator nerve* (long buccal nerve) appears beneath the anterior border of the masseter muscle. On the surface of the buccinator it communicates with the buccal branches of the facial nerve and supplies the skin over the buccinator. Some

filaments pierce the buccinator to supply the mucous membrane of the mouth. The *mental nerve* is derived from the inferior alveolar branch of the mandibular nerve. It emerges with the mental vessels from the mental foramen of the mandible beneath the triangularis. It divides into three branches; two of them communicate with the mandibular branch of the facial nerve and supply the skin and mucous membrane of the lower lip; while the third goes to supply the skin of the chin. The *auriculo-temporal nerve* accompanies the superficial temporal artery lying just behind it. It gives off (1) the *anterior auricular branches* which are two small twigs and supply the skin of the tragus and front part of the helix; (2) *branches to the external acoustic meatus* which are two minute twigs and pass backwards to supply the skin of the external acoustic meatus; (3) the *parotid branches* which supply the parotid gland; (4) the *temporal branches* which are the terminal branches and have been examined during the dissection of the scalp.

Nose (Fig. 87).—The organ of smell is divisible into two portions, an external portion, called the *external nose* and an

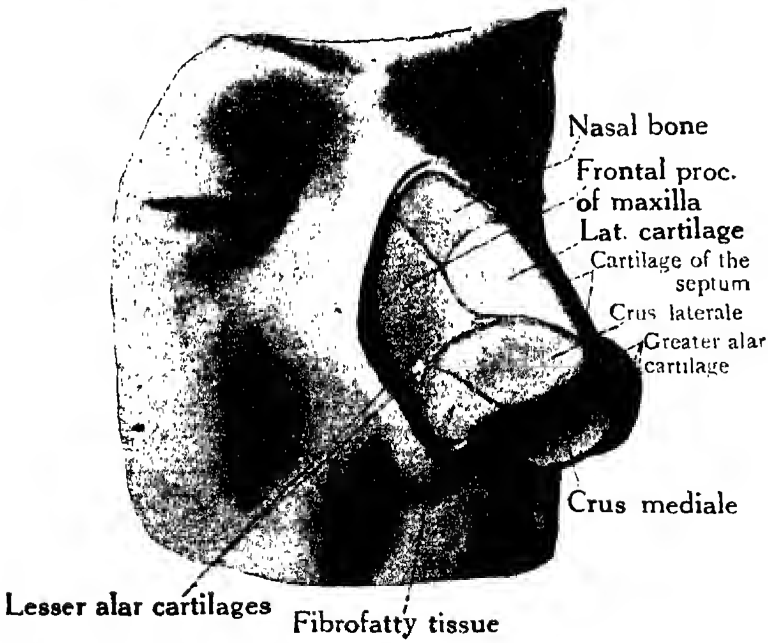

Fig. 87.—The cartilages of the nose (Sobotta).

internal portion, the ***nasal cavity***, which is subdivided by a septum into the right and left nasal cavities. The external nose has the form of a pyramid ; its ***root*** is attached to the forehead ; its free extremity is called the ***apex*** ; its ***base*** presents two orifices called the nostrils or ***anterior nares***, separated by a short partition, the *columna* ; its lateral surfaces meet anteriorly in a rounded edge, the ***dorsum nasi***, the upper part of which is called the *bridge*. The external nose consists of a bony and a cartilaginous framework. The cartilaginous framework consists of five large pieces of cartilage—the two lateral, the two greater alar, and the cartilage of the septum—and some small cartilaginous nodules. These are connected to each other as also to the bony framework by fibrous tissue.

Scrape away the remains of the muscles and examine the cartilages of the nose. The *lateral cartilage* is triangular in shape. Its superior border is attached to the inferior border of the nasal bone and the frontal process of the maxillary bone by fibrous tissue. Its inferior border is connected with the greater alar cartilage by fibrous tissue. The upper part of its anterior border meets its fellow of the opposite side and the septal cartilage, but lower down a narrow interval is seen between the cartilages of the two sides. The *greater alar cartilage* is curved upon itself in such a way as to form the external orifice of the nostril medially, in front, and laterally. Each piece presents a lateral crus and a medial crus. The lateral crus is oval with its long axis directed antero-posteriorly. Above it is attached to the lateral cartilage by fibrous tissue. Behind it is attached to the frontal process of the maxilla by a fibrous membrane in which three or four small pieces of cartilages, called the *lesser alar cartilages*, are embedded. Its lower margin is free. The medial crus is narrow and lies in contact with the medial crus of the opposite side along the middle line connected by fibrous tissue. The *cartilage of the septum* will be studied during the dissection of the nasal cavity.

Structure of the Eyelids.—The eyelids are composed of the following strata aranged successively from without inwards ; (1) skin, (2) subcutaneous tissue, (3) the palpebral portion of the orbicularis oculi, (4) the tarsus, the medial palpebral ligament, the lateral palpebral raphe and the orbital septum—all lying in the same plane ; the expanded aponeurosis of the levator palpebræ superioris is present in addition in the upper eyelid only; (5) tarsal glands ; and (6) the conjunctiva. The first three

strata have been already examined. To expose the fourth stratum, the palpebral portion of the orbicularis oculi is to be removed from the surface of the eyelids.

The **Tarsi** are thin plates of dense connective tissue which give shape to the eyelids. They are two in number, a superior in the upper eyelid and an inferior in the lower eyelid. The *superior tarsus* is the larger and of a semilunar shape. Its convex superior border and the adjoining anterior surface give attachment to the aponeurotic expansion of the levator palpebræ superioris. Its inferior border is straight and covered by the skin at the free margin of the lid. The *inferior tarsus* is a narrow strip of almost equal breadth throughout. To its inferior border is attached the orbital septum. Its superior border is free. The medial ends of the tarsi are attached to the medial wall of the orbit by the *medial palpebral ligament* (tendo oculi). This ligament is attached medially to the frontal process of the maxilla in front of the lacrimal groove; laterally it splits into two slips which are attached to the medial ends of both tarsi. The lateral ends of the tarsi are attached to the lateral walls of the orbit by the *lateral palpebral raphe* (external tarsal ligament). This ligamentous band is weaker than the medial palpebral ligament and is attached laterally to the fronto-sphenoidal process of the zygomatic bone; medially it splits into two slips for attachment to the lateral ends of the two tarsi.

The *orbital septum* or *palpebral fascia* is a membranous sheet which fixes the tarsi to the margins of the orbit, where it is continuous with the periosteum. In the upper eyelid it blends with the superficial lamella of the aponeurosis of the levator palpebræ superioris and is attached to the anterior surface of the upper tarsus. In the lower eyelid it is attached to the inferior border of the lower tarsus. It is pierced by nerves and vessels which leave the orbit.

The *aponeurosis of the levator palpebræ superioris* divides into three lamellæ. The superficial lamella blends with the orbital septum and is attached to the upper part of the anterior surface of the upper tarsus. The intermediate lamella is attached to the superior border of the upper tarsus; the deep lamella, to the upper fornix of the conjunctiva.

The *tarsal glands* (Meibomian glands) are situated on the inner surface of the tarsi. If the eyelids are everted they are seen running in vertical yellow strings in grooves on the inner

surface of the tarsi. The orifices of these glands are placed behind the eyelashes on the free margin of the lids.

The *palpebral conjunctiva* has been already examined.

Blood Vessels of the Eyelids.—These are the medial and lateral palpebral arteries. The *medial palpebral arteries*, two in number, are the branches of the ophthalmic artery. They pierce the orbital septum at the medial palpebral commissure and run lateralwards along the free margins of the eyelids ; one in the upper and the other in the lower. They pass between the tarsus and the orbicularis oculi and anastomose with the lateral palpebral arteries forming an arch. The *lateral palpebral arteries*, two in number, are the branches of the lacrimal artery.They pierce the orbital septum at the lateral palpebral commissure and pass medialwards along the free margins of the eyelids, one in the upper and the other in the lower. They anastomose with the medial palpebral arteries forming an arterial arch, called the *arcus tarseus*.

The **Lacrimal Apparatus** (Fig. 88) consists of (1) the lacrimal gland by which tears are formed and its excretory ducts by which the tears are conveyed to the surface of the eye ; and (2) the lacrimal ducts, the lateral sac, and the nasolacrimal duct by which the tears are conveyed to the cavity of the nose.

Dissection. Divide the orbital septum attached to the lateral half of the superior border of the upper tarsus. The lacrimal gland is exposed. Raise the anterior border of the gland and display the fine ducts emerging from it with fine strokes of the scalpel.

The **Lacrimal Gland** lies in a fossa on the front and lateral part of the roof of the orbit. Its size is like that of an almond. Its upper surface is adapted to the concavity of the fossa and is attached to the periosteum lining it by short fibrous bands. Its under surface lies in contact with the convexity of the eyeball. It is partially subdivided into a superior and an inferior portion by the aponeurosis of the levator palpebræ superioris. The superior portion is called the *superior lacrimal gland* and lies above the aponeurosis, while the inferior portion, called the *inferior lacrimal gland*, lies below it. The two portions however are continuous around the lateral edge of the aponeurosis. From their anterior borders fine *excretory ducts*, six to twelve in number, emerge and open into the lateral part of the superior fornix of the conjunctiva. Minute glandular bodies,

called *accessory lacrimal glands*, are seen in the neighbourhood of the superior fornix.

The **Lacrimal Ducts** or **Canals** begin as minute orifices, called *puncta lacrimalia*, on the free margins of the eyelids at the lateral extremity of the lacus lacrimalis. The *superior duct*, the shorter and narrower of the two, at first ascends and then proceeds medialwards and slightly downwards to open into the lacrimal sac. The *inferior duct* at first descends and then proceeds horizontally medialwards to open into the lacrimal sac. Bristles may be passed through the puncta lacrimalia to the lacrimal sac along these ducts.

The **Lacrimal Sac** is the dilated upper portion of the naso-lacrimal duct. It is oval in shape and lies in the lacrimal groove behind the medial palpebral ligament. Its upper end is closed while below it is continued as a narrow duct called the naso-lacrimal duct. The lacrimal ducts open into its antero-lateral part. A fascia, called the *lacrimal fascia*, stretches from the anterior to the posterior lacrimal crest forming the lateral wall of the lacrimal groove in which the sac is lodged.

The *naso-lacrimal duct* (nasal duct) is the continuation downwards of the lacrimal sac ; it ends in the anterior part of the inferior meatus of the nasal cavity. It lies in the bony canal formed by the lacrimal bone, the frontal process of the maxilla, and the lacrimal process of the inferior nasal concha. It is about half an inch in length. It is directed from above downwards, lateralwards and backwards. This may be ascertained by passing a fine probe through it. The opening of the duct into the inferior meatus is dilated and surrounded by a fold of the mucous membrane called the *plica lacrimalis*, which acts as a valve.

The *lacrimal part of the orbicularis oculi* (tensor tarsi) may now be studied. It arises from the lacrimal fascia, the posterior lacrimal crest and the adjoining lateral surface of the lacrimal bone ; it passes forwards and lateralwards to be inserted into the medial ends of the superior and inferior tarsi. Most of the fibres however are continuous with the palpebral fibres of the orbicularis oculi over the tarsi. It dilates the lacrimal sac and draws the eyelids medialwards.

THE ANTERIOR TRIANGLE OF THE NECK

Dissection. The student should now proceed to dissect the anterior triangle of the neck. The head is made to hang

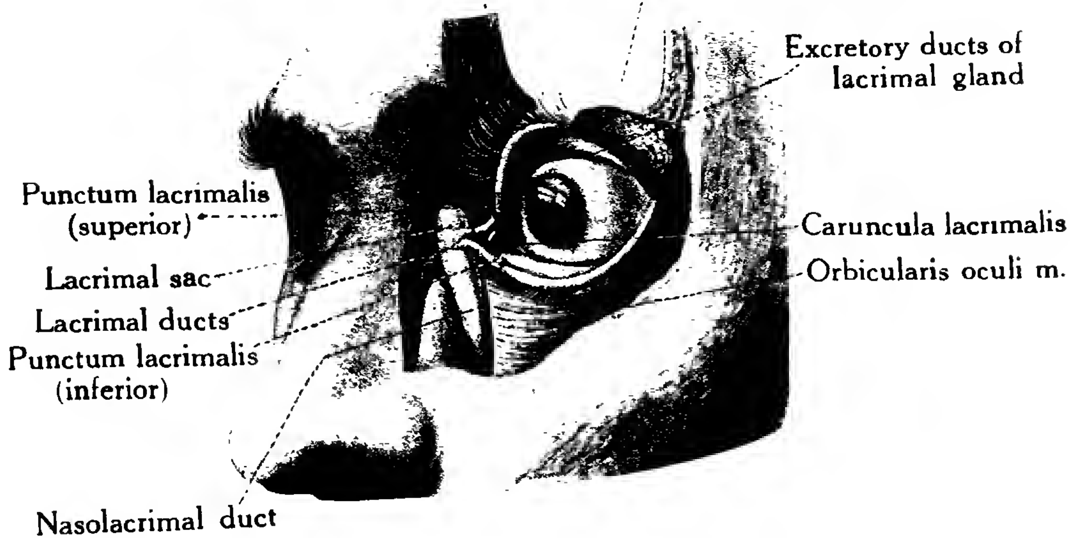

Fig. 88.—The lacrimal apparatus (Sobotta)

To face P. 280.

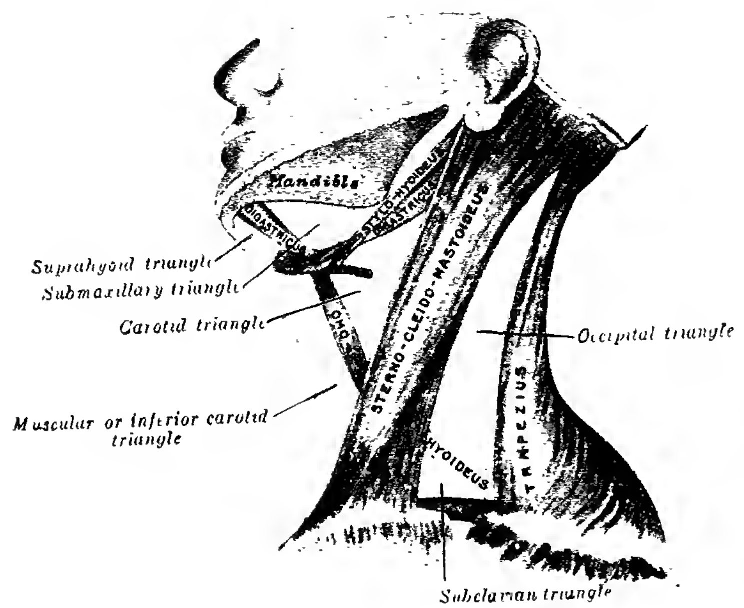

Fig. 89.—Diagram showing the boundaries of the Triangles of the Neck (modified from Gray).

down freely over the edge of the table so that the parts are put on stretch; the mandible is to be fixed with hooks. The head should then be turned over to the opposite side. The superficial nerves are to be reflected backwards and the superficial layer of the fascia colli stretching across the anterior triangle is to be removed.

The **Anterior Triangle** (Fig. 89) is bounded in front by the median line of the neck; behind by the anterior margin of the sternocleidomastoideus. Its base lies above, being formed by the lower border of the body of the mandible and a line drawn from its angle to the mastoid process. Its apex lies below at the sternum. This triangle is subdivided into three smaller triangles by the superior belly of the omohyoideus and the two bellies of the digastric muscle. The three triangles are named from above downwards the submaxillary, the carotid, and the muscular triangles.

Directions. Some of the processes given off from the deep surface of the fascia colli should now be examined and then the student should proceed to expose fully the subdivisions and contents of the anterior triangle

Pretracheal Fascia.—This layer arises from the deep surface of the process of fascia colli which lines the posterior surface of the sterno-cleido-mastoideus. It passes medialwards in front of the carotid arteries and the internal jugular vein contributing to the formation of their sheath (carotid sheath). It proceeds further in front and passes behind the sterno-hyoid and sterno-thyreoid muscles and in front of the thyreoid gland and the trachea and becomes continuous with the corresponding fascia of the opposite side. Above it is attached to the body of the hyoid bone and below it is prolonged downwards into the thoracic cavity behind the sterno-thyreoid and sterno-hyoid muscles where it blends with the fibrous layer of the pericardium. Laterally it is blended with the prevertebral fascia.

The **Carotid Sheath** is the fascial envelope which contains the carotid arteries, the internal jugular vein and the vagus nerve. It is formed in front by the pretracheal fascia, behind by the prevertebral fascia, medially by a fascial process connecting the pretracheal with the prevertebral fascia, and laterally by the fusion of the prevertebral and pretracheal fasciæ. Some regard the carotid sheath as the condensed areolar tissue around the carotid arteries, the internal jugular vein and the vagus nerve—limited in front and behind by the pretracheal and prevertebral fasciæ respectively.

Dissection. The student is now to expose fully the structure contained in the carotid triangle which is limited above by the posterior belly of the digastricus, below by the superior belly of the omohyoideus and behind by the anterior border of the sterno-cleido-mastoideus. The carotid sheath is to be laid open longitudinally, taking care of the descending branch of the hypoglossal nerve which lies either in front of the sheath or embedded in its anterior wall. The contents of the sheath, viz., the carotid arteries, the internal jugular vein, and the vagus nerve are to be separated from one another. The carotid arteries lie medially, the internal jugular vein laterally and the vagus nerve behind and between them. The sympathetic nerve trunk is embedded in the posterior wall of the carotid sheath. The common carotid artery bifurcates into the external and internal carotid arteries at the level of the upper border of the thyreoid cartilage. The external carotid artery lies on a plane medial to and anterior to the internal carotid artery. The branches given off within this triangle from the external carotid artery are to be cleaned; the superior thyreoid artery arises from its anterior aspect; above it are the origins of the lingual and external maxillary arteries; the occipital artery arises from its posterior aspect while the ascending pharyngeal artery passes vertically upwards from its medial aspect close to the commencement of the parent trunk. While cleaning the external carotid artery note that it is surrounded by filaments from the sympathetic which form a plexus around it. From this plexus subsidiary plexuses are prolonged on the branches of the external carotid artery. Look for the union of the anterior facial vein with the anterior division of the posterior facial vein to form the common facial vein near the posterior belly of the digastric and then trace this trunk up to its union with the internal jugular vein behind the sterno-cleido-mastoideus. Trace the lingual, superior, and middle thyreoid veins to their termination in the internal jugular vein. The internal laryngeal nerve is seen to pierce the hyo-thyreoid membrane and enter the larynx. Traced laterally it leads to the superior laryngeal nerve which emerges from behind the internal carotid artery at the side of the pharynx. The external laryngeal branch of the superior laryngeal nerve is a long slender twig which is seen passing downwards by the side of the pharynx to supply the crico-thyreoid muscle. The hypoglossal nerve crosses the carotid arteries from without inwards by hooking round the occipital artery. It gives off the descending branch

in front of the carotid sheath; its thyreoid branch is seen as a slender twig near the greater cornu of the hyoid bone and goes to supply the thyreo-hyoid muscle. Two communicating branches, one from the second and the other from the third cervical nerve are to be searched and traced till they meet to form the descendens cervicalis. This again joins the descending branch of the hypoglossal nerve usually halfway down the neck forming a loop. At the upper part of the triangle the accessory nerve runs downwards and backwards under cover of the posterior belly of the digastricus and pierces the sterno-cleido-mastoideus at its upper part. Note the lymph glands lying along the course of the internal jugular vein and the carotid arteries. These are called the *superior deep cervical lymph glands.* Search for a small oval body, called the glomus caroticum, at the point of the bifurcation of the common carotid artery by turning forwards the posterior surface of the vessel.

The **Carotid Triangle** is *bounded* above by the posterior belly of the digastric muscle, below by the superior belly of the omo-hyoideus and behind by the anterior margin of the sterno-cleido-mastoideus.

The **contents** of the carotid triangle are (Fig. 90) :—

(1) Portions of all the three carotid arteries, viz., the common carotid, the external carotid and the internal carotid.

(2) The superior thyreoid, lingual, external maxillary, occipital, and the ascending pharyngeal branches of the external carotid artery.

(3) The internal jugular vein and some of its tributaries, viz., the common facial, superior thyreoid, lingual, occipital, and ascending pharyngeal veins.

(4) The vagus nerve with its superior laryngeal branch (dividing into external and internal laryngeal nerves), the accessory nerve, the hypoglossal nerve with its descending and thyreo-hyoid branches, and the sympathetic nerve trunk.

(5) Upper portion of the larynx, lower portion of the pharynx and hyoid bone.

(6) Glomus caroticum.

(7) Lymph glands and vessels.

The **floor** of the carotid triangle is formed by the thyreo-hyoideus, hyoglossus, and the middle and inferior constrictors of the pharynx.

Dissection. Now proceed to dissect the submaxillary triangle lying between the two bellies of the digastricus and limited

above by the lower border of the body of the mandible and a line from the angle of the mandible to the mastoid process. The submaxillary gland is seen exposed under the lower jaw ; clean the gland and displace it upwards from the surface of the mylohyoid muscle and fix it with hooks. Clean the aponeurotic band derived from the fascia colli which binds the intermediate tendon of the digastricus to the body of the hyoid bone. When the structures of the triangle are studied the mylohyoid and hyoglossus are to be cleaned. The external carotid artery reaches the posterior part of the triangle and gives off the posterior auricular branch. The external maxillary artery passes through the submaxillary gland and reaches the groove in the mandible in front of the anterior margin of the masseter. Its branches given off in the neck should be traced. The anterior facial vein passes superficial to the submaxillary gland. The mylohyoid nerve accompanies the mylohyoid artery and lies on the surface on the mylohyoideus. Several lymph glands are seen beneath the lower border of the mandible and on the superficial surface of the submaxillary gland. The internal carotid artery, the internal jugular vein, the glosso-pharyngeal and vagus nerves are placed deeply in the posterior part of the triangle. The hypoglossal nerve is also seen at the posterior border of the mylohyoid and the lingual vein lies below the nerve.

The **Submaxillary or Digastric Triangle** is *bounded* above by the lower border of the mandible and a line joining its angle to the mastoid process, below by the posterior belly of the digastric and the stylo-hyoideus, in front by the anterior belly of the digastric.

The **contents** of the submaxillary triangle are (Fig. 90) :—

1. The external carotid artery with its posterior auricular branch ; the external maxillary artery with its cervical branches, viz., the ascending palatine, tonsillar, glandular and submaxillary branches ; the mylohyoid artery ; the internal jugular and the anterior facial veins.

2. The glossopharyngeal, vagus and hypoglossal nerves ; and the mylohyoid nerve.

3. The submaxillary gland ; lower portion of the parotid gland and submaxillary lymph glands.

The **floor** of the submaxillary triangle is formed by the mylohyoideus, hyoglossus, and superior constrictor of the pharynx.

Dissection. The student should now proceed to dissect

Fig. 90.—Deep dissection of the Triangles of the Neck (Sobotta).

To face P. 284.

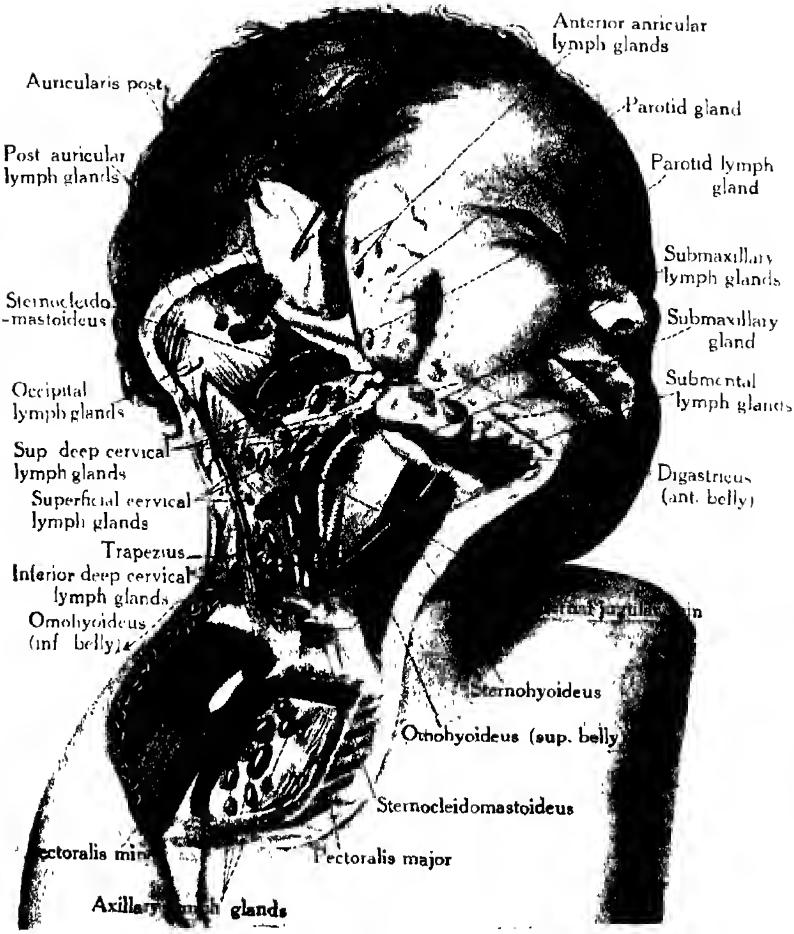

Fig 91.—The lymph glands of the head, neck and axilla (Sobotta).

the muscular triangle lying between the anterior border of the sterno-cleido-mastoideus, the superior belly of the omohyoideus and the middle line of the neck. Define the sterno-hyoideus and sterno-thyreoideus muscles. The former is placed superficially covering the latter muscle. The superior thyreoid artery is seen to descend beneath these muscles to end in the thyreoid gland. Nerve filaments for the supply of these muscles will be seen coming from the ansa hypoglossi or the loop formed by the descending branch of hypoglossal nerve with the descendens cervicalis ; the latter is formed by the union of the communicantes cervicales which are derived from the second and third cervical nerves. The external laryngeal nerve should be traced to its termination in the cricothyreoid muscle. The recurrent nerve is placed in the groove between the trachea and œsophagus. Beneath the sterno-hyoid and sterno-thyreoid muscles are seen the larynx, the trachea and the thyreoid gland.

The **Muscular Triangle** is bounded in front by the median line of the neck ; behind and below by the anterior margin of the sterno-cleido-mastoideus ; behind and above by the superior belly of the omohyoideus.

The **contents** of the muscular triangle are (Fig. 90) :—

1. The sterno-hyoid and sterno-thyreoid muscles.
2. The superior thyreoid artery.
3. The recurrent and external laryngeal nerves ; twigs from the ansa hypoglossi to the sterno-hyoid and sterno-thyreoid muscles.
4. The lower portion of the larynx, the trachea, the thyreoid gland and the œsophagus.

The **Submental** or **Suprahyoid Triangle** is another triangular space often described in connection with the subdivisions of the anterior triangle of the neck. It is *bounded* behind by the anterior belly of the digastricus ; below by the body of the hyoid bone ; in front by the middle line of the neck. Its floor is formed by the mylohyoid muscle. In this space are seen one or two lymph glands and some minute veins which are the radicles of the anterior jugular vein.

The dissector should now proceed to study each one of the structures in its entirety as exposed in the different divisions of the anterior triangle of the neck.

The **Descending Branch of Hypoglossal Nerve** issues as the hypoglossal nerve hooks round the occipital artery. It descends in front of or is embedded in the anterior wall of the carotid sheath. Reaching the middle of the neck it joins the

descendens cervicalis which is formed by the union of the communicantes cervicales to form a loop, called the *ansa hypoglossi*. Before forming a loop it gives a twig to the superior belly of the omohyoid and from the loop itself branches are given off to the inferior belly of the omo-hyoid, sterno-hyoid and sterno-thyreoid muscles.

The **Omohyoideus** consists of a superior and an inferior muscular belly and an intermediate tendon. The *inferior belly* arises from the superior transverse scapular ligament and the adjacent superior border of the scapula. It subdivides the posterior triangle into the occipital and subclavian triangles. Beneath the sterno-cleido-mastoideus it ends in the intermediate tendon. From this tendon the *superior belly* passes upwards and medialwards to be inserted into the lower border of the body of the hyoid bone lateral to the insertion of the sterno-hyoideus. It divides the anterior triangle into the carotid and muscular triangles. The intermediate tendon is held in position by a process of the fascia colli which is attached below to the clavicle and first rib. *Nerve-supply.*—The superior belly is supplied by a twig from the descending branch of the hypoglossal nerve. The twig which enters the inferior belly comes from the ansa hypoglossi. *Action.*—It depresses the hyoid bone and draws it backwards.

The **Sterno-hyoideus** is a thin flat muscle which arises (1) from the posterior surface of the medial end of the clavicle, (2) from the articular capsule of the sterno-clavicular joint, and (3) from the posterior surface of the manubrium sterni. It is inserted into the lower border of the body of the hyoid bone just medial to the insertion of the omohyoideus. It is supplied by a branch from the ansa hypoglossi. It depresses the hyoid bone.

Dissection. Divide the sterno-hyoideus at its middle and reflect the divided ends upwards and downwards. The sterno-thyreoideus and thyreo-hyoideus are exposed.

The **Sterno-thyreoideus** is broader but shorter than the sterno-hyoideus. It arises from the posterior surface of the manubrium sterni below the origin of the sterno-hyoideus and from the adjoining cartilage of the first rib. It is inserted into the oblique line on the lateral surface of the lamina of the thyreoid cartilage. A branch from the ansa hypoglossi supplies this muscle. It draws downwards the larynx.

The **Thyreohyoideus** is practically the prolongation upwards of the preceding muscle. It arises from the oblique line on the

lateral surface of the lamina of the thyreoid cartilage and is inserted into the lower border of the greater cornu of the hyoid bone. It is supplied by a slender filament from the hypoglossal nerve. It draws up the larynx towards the hyoid bone, or depresses the hyoid bone.

The **Digastricus** consists of two muscular bellies and an intermediate tendon. The *anterior belly* arises from a depression on the inner side of the lower border of the mandible close to the symphysis menti. The *posterior belly* arises from the mastoid notch on the medial side of the mastoid process of the temporal bone. The *intermediate tendon* pierces the insertion of the stylohyoideus and is attached to the side of the body of the hyoid bone by a fibrous loop derived from the fascia colli. A fibrous layer, the *suprahyoid aponeurosis*, stretches from the intermediate tendon to the hyoid bone. The anterior belly is supplied by the mylohyoid branch of the inferior alveolar nerve; the posterior belly by the facial nerve. When the posterior belly is fixed the anterior belly depresses the mandible and opens the mouth. When the anterior belly is fixed the posterior belly throws the head backwards. If both bellies act together, the hyoid bone is elevated.

The **Stylohyoideus** is a slender muscle which arises from the lateral and back part of the styloid process near its root. It is inserted into the body of the hyoid bone at its junction with the greater cornu. The tendon of the digastricus pierces this muscle near its insertion. It is supplied by the facial nerve. It elevates the hyoid bone.

Dissection. Divide the sterno-cleido-mastoideus at its attachment to the sternum and clavicle. Reflect the muscle upwards as far as practicable without destroying the vessels and nerve filaments entering it. Dissect fully the contents of the carotid sheath (p. 281) which lie under cover of the muscle. Next clean the scaleni muscles. These are three in number, anterior, middle and posterior. When these have been studied dissect out the first and second portions of the subclavian artery with its branches and note the sympathetic filaments which surround them. Lastly clean the subclavian vein.

The **Scalenus Anterior** arises from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ. It is inserted into the scalene tubercle on the inner border and upper surface of the first rib. The muscle lies immediately behind the clavicle and the sternocleidomas-

toideus, and a large number of important structures are in relation with it. Thus *in front* the phrenic nerve crosses it obliquely from the lateral to the medial side, while the transverse scapular and the transverse cervical vessels, the subclavian vein and the omohyoideus cross it more or less transversely. *Behind* the muscle are seen the second part of the subclavian artery and the brachial plexus of nerves. Along its *medial* margin, the internal jugular vein descends to unite with the subclavian vein in front of the muscle. The thyreocervical trunk with its inferior thyreoid branch and the vertebral artery also lie medially.

The **Scalenus Medius**, the largest of the three scaleni, arises from the posterior tubercles of the transverse processes of the lower six cervical vertebræ and is inserted into a rough impression on the upper surface of the first rib extending from the groove for the subclavian artery to the tubercle of the rib.

The **Scalenus Posterior**, the smallest of the three scaleni, arises from the posterior tubercles of the lower two or three cervical vertebræ and is inserted into the outer surface of the second rib just behind the attachment of the serratus anterior.

The scaleni are supplied by twigs from the anterior divisions of the second to the seventh cervical nerves. Each muscle elevates the particular rib to which it is attached and bends the cervical portion of the vertebral column laterwards.

Relations of the sterno-cleido-mastoideus.—As this muscle has been cut and reflected the student can examine all its relations fully. Its *superficial surface* is covered by the platysma and the fascia colli and is traversed by the external jugular vein, the great auricular and cervical cutaneous nerves. Its *deep surface* is in relation with the sternohyoid, sternothyreoid, omohyoid, posterior belly of digastric, levator scapulæ, splenius and scaleni muscles, the upper part of the common carotid artery and the origins of the external and internal carotid arteries, the occipital, subclavian, transverse cervical and transverse scapular arteries and veins, the internal and anterior jugular veins, the cervical plexus, the upper part of the brachial plexus, the communicantes cervicales, descending branch of hypoglossal nerve, and the phrenic, vagus, accessory and hypoglossal nerves and portions of the thyreoid and parotid glands.

The **Subclavian Artery** begins on the right side from the bifurcation of the innominate artery behind the right sterno-clavicular joint and on the left side from the arch of the aorta. The left vessel has therefore an additional intrathoracic portion

which has been examined (p. 177). It is customary to divide the vessel into three portions : the first portion extends from the origin of the vessel to the medial margin of the scalenus anterior ; the second portion lies behind that muscle ; and the third portion extends from the lateral margin of the scalenus anterior to the outer border of the first rib. The first portion of the vessel presents differences in its relations on the two sides of the body, while the second and third portions exhibit same relations on the two sides. Sympathetic nerve filaments surround the subclavian artery and are prolonged on its branches.

First portion.—The first portion of the right vessel corresponds in position to the cervical part of the first portion of the left vessel. The relations of the thoracic part of the left subclavian artery have been examined during the dissection of the thorax. On the right side the artery runs upwards and lateralwards from its commencement to the medial margin of the scalenus anterior. On the left side the artery passes almost directly lateralwards from the root of the neck to the medial border of the scalenus anterior. The common relations of the arteries on both sides are :—*in front* with the skin, superficial fascia, platysma and

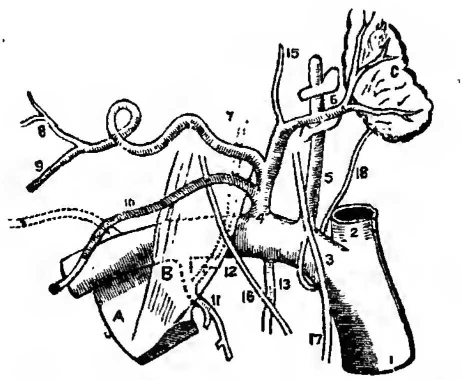

Fig. 92.—Diagram of the subclavian artery and its branches (Turner).

A. First rib.
B. Scalenus anterior.
C. Thyreoid body.
1. Innominate artery.
2. Right common carotid artery.
3. Right subclavian artery.
4. Thyreo-cervical trunk.
5. Vertebral artery.
6. Inferior thyreoid artery.
7. Transverse cervical artery.
8. Its ascending branch.
9. Its descending branch.
10. Transverse scapular artery.
11. Superior intercostal artery
12. Arteria profunda cervicis.
13. Internal mammary artery
15. Ascending cervical artery.
16. Phrenic nerve.
17. Vagus nerve.
18. Right recurrent nerve.

deep fascia ; with three muscles—the sterno-cleido-mastoideus, the sterno-thyreoideus and the sterno-hyoideus ; with three veins—the internal jugular, the anterior jugular, and vertebral veins ; and with the vagus nerve, its cardiac branches and the cardiac branches of the sympathetic nerve. *Behind* it is the sympathetic trunk, as also the longus colli and the cervical pleura. *Relations* peculiar on the two sides :—on the right side the artery is encircled by a loop of the sympathetic trunk and the right recurrent nerve hooks below and behind the artery. On the left side the phrenic nerve and the left innominate vein lie in front of it and the thoracic duct lies at first medial to the artery and then arches above it.

Second portion.—This part is covered by (1) the superficial structures, viz., the skin, superficial fascia, platysma and deep cervical fascia, (2) clavicular head of sterno-cleido-mastoideus, (3) the phrenic nerve (on the right side), (4) the scalenus anterior, (5) the subclavian vein. The phrenic nerve owing to its greater obliquity on the left side becomes related to the first portion of the vessel on the left side and not to the second portion. The subclavian vein lies on a slightly lower level and separated from the artery by the scalenus anterior. Behind and below the artery is the pleura ; above, is the brachial plexus.

Third portion.—This part of the artery has been described (p. 256).

Branches of the Subclavian Artery.—These are four in number, viz., (1) vertebral, (2) thyreocervical trunk, (3) internal mammary, (4) costocervical.

The **Vertebral Artery** issues form the upper and back part of the first portion of the subclavian artery, passes upwards between the contiguous borders of the scalenus anterior and longus colli and enters the foramen in the transverse process of the sixth cervical vertebra—this constitutes the *first part* of the artery. It lies under cover of the vertebral and internal jugular veins and is crossed by the thoracic duct on the left side. Its further course will be studied later on. The *vertebral vein* after its exit from the foramen in the transverse process of the sixth cervical vertebra opens into the innominate vein at its commencement.

The **Thyreocervical Trunk** (Thyreoid axis) is a short vessel which arises from the front aspect of the first portion of the subclavian artery close to the medial border of the scalenus anterior. It divides almost immediately into three terminal

branches viz., the inferior thyreoid, the transverse cervical and the transverse scapular.

The **Inferior Thyreoid Artery** runs at first upwards in front of the vertebral artery and the longus colli. Then it turns medialwards behind the internal jugular vein, the common carotid artery, the vagus nerve and the sympathetic trunk to reach the posterior border of the thyreoid gland. It then descends along this border to terminate in the lower end of the gland. It gives off the following branches:—(1) the *ascending cervical* which runs upwards between the contiguous borders of the scalenus anterior and the longus capitis. It gives off twigs to the prevertebral muscles and one or two *spinal branches* which enter through the intervertebral foramina. The distribution of these spinal branches to the medulla spinalis and its membranes has been examined. (2) The *inferior laryngeal artery* passes upwards upon the trachea in company with the recurrent nerve to supply the muscles and mucous membrane of the larynx. (3) The *tracheal branches* supply the trachea and anastomose with the bronchial arteries. (4) The *œsophageal branches* supply the œsophagus and anastomose with the œsophageal branches of the thoracic aorta. (5) The *glandular branches* are usually two in number, an ascending branch which supplies the posterior part of the thyreoid gland and an inferior branch which supplies its lower end. They anastomose with the superior thyreoid artery and with the artery of the opposite side. (6) The *muscular branches* are small twigs which supply the neighbouring muscles. The *inferior thyreoid vein* does not run along with the artery. It emerges from the thyreoid gland and descends in front of the trachea and beneath the sterno-thyreoid muscle to enter the thorax. Its termination in the innominate vein has been examined (p. 176). Its tributaries correspond to the inferior laryngeal, tracheal and œsophageal branches of the inferior thyreoid artery. The companion vein of the ascending cervical artery is called the *anterior vertebral vein* and terminates in the vertebral vein.

The **Transverse Cervical Artery** runs lateralwards across the scalenus anterior, the phrenic nerve and the brachial plexus and is covered by the sterno-cleido-mastoideus. Its further course has been examined (p. 257).

The **Transverse Scapular Artery** is placed on a lower level than the transverse cervical artery. It runs lateralwards along the root of the neck under cover of the sterno-cleido-mastoideus

and crosses the lower end of the scalenus anterior, the phrenic nerve, the subclavian artery and the brachial plexus. Its course up to the upper border of the scapula has been examined (p. 257). The *transverse cervical* and *transverse scapular veins* open into the external jugular vein.

The **Internal Mammary Artery** arises from the lower aspect of the first portion of the subclavian artery just opposite the thyreo-cervical trunk. In the neck it is covered by the subclavian vein and is crossed by the phrenic nerve from the lateral to the medial side. Its thoracic portion has been described (p. 144). Its companion vein terminates in the innominate vein (p. 176).

The **Costocervical Artery** (Superior intercostal artery) arises from the posterior aspect of the second portion of the subclavian artery close to the medial border of the scalenus anterior on the right side. On the left side it springs from the first portion of the parent trunk. It passes backwards above the apex of the cervical pleura towards the neck of the first rib and divides into the arteria cervicalis profunda and the arteria intercostalis suprema. The *arteria cervicalis profunda* runs backwards between the transverse process of the seventh cervical vertebra and the neck of the first rib and ascends on the posterior aspect of the neck. Its further course has been studied (p. 233). The *deep cervical vein* opens into the vertebral vein. The *arteria intercostalis suprema* runs downwards in front of the necks of the first and second ribs and anastomoses with the first aortic intercostal artery. It gives off a posterior intercostal branch in the first intercostal space and terminates as the posterior intercostal artery of the second space. The intercostal veins corresponding to the arteries in the first two intercostal spaces have been examined (p. 190).

The **Subclavian Vein** is the continuation of the axillary vein. It begins at the outer border of the first rib and ends behind the medial end of the clavicle where it joins the internal jugular vein to form the innominate vein. Below it lies upon a groove on the first rib. Above and behind it is the subclavian artery from which it is separated by the scalenus anterior and the phrenic nerve. Its *tributary* is the external jugular vein. Into the angle of union of the subclavian and internal jugular veins on the right side, the right lymphatic duct opens; and in the corresponding place on the left side, the thoracic duct ends.

Dissection. Look for the thoracic duct on the left side of the œsophagus and note that as it passes into the neck it arches lateralwards about an inch and a quarter above the clavicle. The right lymphatic duct should be searched near its termination at the angle of junction of the internal jugular and subclavian veins, and then traced downwards. Next clean the cervical pleura and exmine its relations.

Thoracic Duct.—Its cervical portion is now to be examined. After its exit from the upper opening of the thorax it appears at the root of the neck on the left side lying between the œsophagus and the cervical pleura. Then it arches lateralwards and forwards behind the common carotid artery, the vagus nerve and the internal jugular vein and lies above the arch formed by the subclavian artery. In its course it crosses the vertebral artery and vein, the thyreo-cervical trunk and the scalenus anterior muscle. It then turns downwards in front of the subclavian artery to open into the angle of junction of the internal jugular vein with the subclavian vein. At its termination it is guarded by a pair of valves.

Tributaries of the cervical part of the thoracic duct.—These are : (1) the *left jugular trunk* which drains lymph from the left side of the head and neck ; (2) the *left subclavian trunk* which drains lymph from the left superior extremity ; and (3) the *left bronchomediastinal trunk* which drains lymph from the left side of the thorax.

The **Right Lymphatic Duct** corresponds on the right side to the thoracic duct on the left side. It is about half an inch in length and passes along the medial border of the scalenus anterior to open into the angle of junction of the right internal jugular and right subclavian veins. At its termination it is guarded by a pair of semilunar valves. It is formed by the union of (1) the *right jugular trunk* which drains lymph from the right side of the head and neck ; (2) the *right subclavian trunk* which drains lymph from the right superior extremity ; and (3) the *right broncho-mediastinal trunk* (p. 185).

The **Cervical Pleura** has been described (p. 148). Its *relations* may now be examined. It is completely covered by Sibson's fascia. It is covered antero-laterally by the scalenus anterior ; a few fibres of the muscle spread over and strengthen it. The subclavian artery crosses the cervical pleura below its apex. The costocervical artery ascends and crosses its apex ; the arteria intercostalis suprema descends and lies posterior to its apex.

The internal mammary artery descends from the subclavian upon it. The subclavian vein lies below the companion artery from which it is separated by the scalenus anterior.

The student should now proceed to study the common carotid artery and the external carotid artery with its branches.

The **Common Carotid Artery** begins on the right side behind the right sterno-clavicular articulation at the bifurcation of the innominate artery, while on the left side it springs from the arch of the aorta. On each side the vessel terminates on a level with the upper border of the thyreoid cartilage by dividing into the external and internal carotid arteries. The left artery has therefore an additional intrathoracic portion (p. 177). The right common carotid artery and the cervical portion of the left common carotid artery resemble each other closely in their relations. At the lower part of the neck the common carotid arteries are deeply placed and are separated from each other by the trachea and œsophagus. At the upper part of the neck they are more superficial and are separated from each other by the thyreoid cartilage and the pharynx. Each artery is contained in the carotid sheath, the contents of which with their relative positions have been examined. The structures lying *in front* of the vessel are :—the skin, superficial fascia, platysma, fascia colli and the sterno-cleido-mastoideus (throughout the entire length of the vessel) ; the descending branch of the hypoglossal nerve and the branches from the ansa hypoglossi descend in front of the sheath of the vessel ; the sterno-hyoid and sterno-thyreoid muscles lie in front of it (at its lower part), the omohyoid muscle passes over it opposite the cricoid cartilage ; the sterno-cleido-mastoid branch of the superior thyreoid artery, the superior and middle thyreoid veins cross the vessel from the medial to the lateral side. *Behind* it are the longus colli and capitis, the inferior thyreoid artery, the sympathetic trunk, the recurrent nerve (on the right side) and the thoracic duct on the left side. To its ***lateral side*** are the internal jugular vein and the vagus nerve ; to its ***medial side*** are the larynx and trachea, the pharynx and the œsophagus, the inferior thyreoid artery, the recurrent nerve and the thyreoid gland. No branches are given off from the common carotid artery.

Glomus Caroticum (Carotid body).—This is a small reddish brown, oval body seen on the posterior aspect of the common carotid artery at the point of its bifurcation. It is closely connected with filaments derived from the sympathetic plexus

around the carotid artery and several arterial twigs enter into its constitution. Its function is unknown.

The **External Carotid Artery** begins opposite the upper border of the thyreoid cartilage at the bifurcation of the common carotid artery and ends in the substance of the parotid gland behind the neck of the mandible by dividing into two branches, the superficial temporal and internal maxillary arteries. At its commencement it lies medial to and more superficial than the internal carotid artery. Here it is contained in the carotid triangle and has *in front* of it the deep fascia and the anterior margin of the sterno-cleido-mastoideus. It is crossed by the lingual and common facial veins and the hypoglossal nerve. Higher up as it enters the posterior part of the submaxillary triangle it is crossed by the digastric and stylohyoid muscles. Still higher up where it enters the substance of the parotid gland it lies beneath the facial nerve and the posterior facial vein. *Behind* the artery there are two muscles, the styloglossus and the stylopharyngeus, and two nerves, the glossopharyngeal and the pharyngeal branch of the vagus nerve. The two nerves separate the external from the internal carotid artery. *Lateral* to it is the internal carotid artery while *medially* are the pharynx, and the superior laryngeal nerve dividing into its external and internal laryngeal branches and the posterior border of the ramus of the mandible.

Branches.—The branches of the external carotid artery may be grouped into anterior, posterior and ascending sets.

Anterior.	*Posterior.*	*Ascending.*
Superior thyreoid.	Occipital.	Ascending pharyngeal.
Lingual.	Posterior auricular.	Superficial temporal.
External maxillary.		
Internal maxillary.		

The **Superior Thyreoid Artery** arises just below the greater cornu of the hyoid bone and passes forwards and downwards beneath the omohyoid, sternohyoid and sternothyreoid muscles to end in the thyreoid gland. It gives off the following branches :—(1) The *hyoid branch* passes along the lower border of the hyoid bone beneath the thyreohyoid muscle, supplies the muscle and anastomoses with its fellow of the oppposite side. (2) The *sterno-cleido-mastoid artery* passes obliquely downwards and backwards across the carotid sheath to enter the substance of the sterno-cleido-mastoideus. (3) The *superior laryngeal artery* passes in company with the internal laryngeal nerve beneath the thyreo-

hyoid muscle and pierces the hyothyreoid membrane to supply the interior of the larynx. (4) The *cricothyreoid branch* runs transversely medialwards across the cricothyreoid membrane and anastomoses with the artery of the opposite side. (5) The *glandular branches* are the terminal branches which are two or three in number and supply both surfaces of the thyreoid gland ; one of these passes along the isthmus of the thyreoid gland to anastomose with its fellow of the opposite side.

The *superior thyreoid vein* begins in the thyreoid gland, receives tributaries corresponding mostly to the branches of the artery and terminates in the internal jugular vein.

The **Lingual Artery** arises above the origin of the superior thyreoid opposite the greater cornu of the hyoid bone. The *first part* of the artery is contained within the carotid triangle and lies upon the middle constrictor muscle of the phaynx. At first it ascends and then bends downwards forming a loop and passes beneath the digastricus and stylohyoideus. Reaching the posterior border of the hyoglossus it gives off the *hyoid branch*, which passes medialwards along the upper border of the hyoid bone, supplies the neighbouring muscles and anastomoses with its fellow of the opposite side. The rest of the course of the artery and its other branches will be examined later on.

The **External Maxillary Artery** (Facial artery) arises above the lingual and may be divided into two portions—the first or *cervical portion*, which extends from the origin of the artery to the groove in the mandible at the antero-inferior angle of masseter muscle ; and the second or *facial portion* which has been already studied. The cervical portion of the artery runs upwards and forwards and is at first contained in the carotid triangle ; then it passes under the posterior belly of the digastric and stylohyoid muscles and reaches the submaxillary triangle where it is embedded in the posterior part of the submaxillary gland. The following branches (*cervical branches*) are given off in the neck :—(1) the *ascending palatine artery* which passes upwards along the lateral wall of the pharynx between the styloglossus and stylopharyngeus. Its terminal branches which enter the pharynx cannot be examined now. (2) The *tonsillar branch* passes upwards between the styloglossus and the pterygoideus internus and pierces the pharyngeal wall to supply the tonsil and back part of the tongue. (3) The *glandular branches* supply the submaxillary gland. (4) The *submental artery* runs forwards upon the mylohyoid muscle below the lower border

of the mandible. Near the symphysis menti it turns upwards over the chin to supply the lower lip and anastomose with the mental and inferior labial arteries. In its course it supplies the submaxillary lymph glands, the mylohyoid muscle and anastomoses with the sublingual artery by piercing the muscle. It also anastomoses with the mylohyoid branch of the inferior alveolar artery.

Anterior Facial Vein (Facial vein).—Its facial portion has been examined. Its cervical portion receives tributaries corresponding to the branches of the cervical portion of the external maxillary artery and unites with the anterior division of the posterior facial vein to form the *common facial vein* which opens into the internal jugular vein.

The **Occipital Artery** arises from the back part of the external carotid opposite the origin of the external maxillary artery. It runs upwards and backwards along the lower border of the posterior belly of the digastricus to reach the space between the transverse process of the atlas and the mastoid process of the temporal bone. Its further course in the scalp has been already examined. The artery presents three stages in its course. The first stage lies anterior to the sterno-cleido-mastoid muscle. Here it crosses the internal carotid artery, internal jugular vein, the vagus and accessory nerves while the hypoglossal nerve hooks round the vessel from behind forwards. The second stage lies under cover of the sterno-cleido-mastoid, splenius capitis, longissimus capitis and digastric muscles. The third stage constitutes the portion which ramifies in the scalp (p. 199). The *branches* from the first stage are : (1) the *sterno-cleido-mastoid branch* which passes downwards and backwards and enters the sterno-cleido-mastoid muscle in company with the accessory nerve. (2) The *meningeal branch* which accompanies the internal jugular vein and enters the posterior fossa of the skull through the jugular foramen where it supplies the dura mater. From the second part of the artery *muscular branches* are given off to the neighbouring muscles, viz., the digastricus, stylohyoideus, splenius and longissimus capitis.

The *occipital vein* usually joins the deep cervical and vertebral veins ; occasionally it opens into the internal jugular vein.

The **Posterior Auricular Artery** arises from the external carotid above the posterior belly of the digastricus. At first it is placed deeply and runs upwards and backwards under cover of the parotid gland, over the styloid process of the temporal

bone and reaches the interval between the mastoid process and the cartilage of the external ear. Here its terminal branches have been examined during the dissection of the scalp (p. 199). Besides those terminal branches it gives off (1) *muscular branches* to the neighbouring muscles, (2) *glandular branches* to the parotid gland, and (3) the *stylomastoid artery* which enters the stylomastoid foramen, supplies the mastoid cells and the tympanic cavity and anastomoses in the facial canal with the petrosal branch of the middle meningeal artery.

The *posterior auricular vein* has been seen to unite with the posterior division of the posterior facial vein near the angle of the mandible to form the external jugular vein.

The **Ascending Pharyngeal Artery** issues from the external carotid near its origin. It passes upwards between the internal carotid artery and the lateral side of the pharynx to the base of the skull. It will be examined again during the deep dissection of the neck.

The **Superficial Temporal Artery** has been examined during the dissection of the face (p. 272).

The **Internal Maxillary Artery** will be examined during the dissection of the infratemporal region.

Cervical Plexus.—This plexus (Fig. 93) is formed by the anterior divisions of the upper four cervical nerves and lies between the sterno-cleido-mastoideus in front and the levator scapulæ and scalenus medius behind. The anterior divisions of the second, third and fourth cervical nerves divide each into an ascending

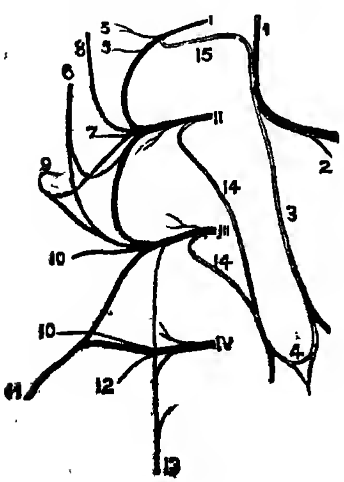

Fig. 93.—Diagram of the cervical plexus (Cunningham).

I, II, III, IV. Anterior primary divisions of the upper four cervical nerves.

1. Hypoglossal nerve.
2. Thyreo-hyoid nerve.
3. Descendens hypoglossi.
4. Ansa hypoglossi.
5. Branches to recti.
6. Great auricular nerve.
7. Branch to sterno-cleido-mastoideus
8. Small occipital nerve.
9. Nervus cutaneus colli.
10. Branches to levator scapulæ

and a descending branch which unite with each other forming loops. The ascending branch of the second cervical nerve joins the undivided anterior division of the first cervical nerve above while the descending branch of the fourth cervical nerve, joins the fifth nerve below to enter into the formation of the brachial plexus. The cervical plexus consists of three loops ; the first loop is formed by the first and second cervical nerves, the second loop by the second and third nerves ; and the third loop by the third and fourth nerves The *branches* of the cervical plexus may be classified as follows :—

Superficial	Ascending	Smaller occipital. Great auricular.
	Transverse	Nervus cutaneus colli.
	Descending	Anterior supraclavicular. Middle supraclavicular. Posterior supraclavicular.
Deep	Muscular. Communicating.	

The *superficial branches* have been examined.

Muscular branches.—The rectus capitis anterior, rectus capitis lateralis and longus capitis are supplied from the loop formed by the first and second cervical nerves. These twigs pass medialwards to supply the muscles. The sterno-cleido-mastoideus is supplied from the second cervical nerve which communicates with the accessory nerve in the muscle. The levator scapulæ, scalenus medius, trapezius and longus colli are supplied from the third and fourth cervical nerves. The diaphragm is supplied by the phrenic nerve which should be studied in detail.

The **Phrenic Nerve** arises chiefly from the fourth cervical nerve, but it receives a filament from the third and another from the fifth cervical nerve. It is formed at the lateral margin of the scalenus anterior and crosses that muscle obliquely from the lateral to the medial side and then descends to the root of the neck. In its course in the neck it is covered by the sterno-cleido-mastoideus, the inferior belly of the omohyoideus, the transverse cervical and transverse scapular vessels and the subclavian vein. It next crosses the internal mammary artery and enters the thorax. Its course within the thorax has been described (p. 150).

The *communicating branches of the cervical plexus* are :—(1) The *communicantes cervicales.* These consist of two branches one from the second and the other from the third cervical nerve.

These two branches unite to form the *descendens cervicalis* which descends along the lateral side of the internal jugular vein and unites with the descending branch of hypoglossal nerve about the middle of the neck to form the ansa hypoglossi. (2) *Communicating branches to the accessory nerve.*—The branch from the second cervical nerve which supplies the sterno-cleido-mastoid muscle communicates with the accessory nerve in the substance of the muscle. The branches from the third and fourth cervical nerves which supply the trapezius communicate with the accessory nerve underneath the muscle. (3) *Communicating branches to the vagus and hypoglossal nerves.*—These proceed from the loop formed by the first and second cervical nerves to the base of the skull and will be examined at a later stage of dissection. (4) *Grey rami communicantes.* These connect the superior cervical ganglion of the sympathetic trunk to each of the upper four cervical nerves.

The dissector should now proceed to examine the thyreoid gland, the cervical portions of the trachea and the œsophagus.

The **Thyreoid Gland** (Fig. 94) is a ductless gland situated at the front and sides of the neck. It consists of two lateral lobes joined across the middle line by a narrow transverse band called the *isthmus*. It is usually larger in the female than in the male. It is enclosed by the pretracheal layer of the fascia colli which constitutes its *sheath*. It is also enclosed by its own *capsule* of connective tissue which sends septa into its substance. Between the sheath and the capsule are seen arteries which enter into the gland and small veins which come out of the gland and unite to form the thyreoid veins. Each lobe is conical in shape with its *apex* above at the level of the junction of the lower with the middle third of the thyreoid cartilage; the *base* is on a level with the fifth or sixth tracheal ring. Its *lateral surface* is convex and covered by the superior belly of the omohyoid, sterno-hyoid and sterno-thyreoid muscles. Its *medial surface* is concave being moulded over the trachea, the cricoid and thyreoid cartilages. Its *posterior border* lies in contact with the œsophagus and pharynx and usually overlaps the common carotid artery. The *anterior border* is thinner than the posterior and extends along the middle line of the neck. The isthmus joins the lower parts of the anterior borders of the lobes and lies opposite the second and third rings of the trachea. From the upper part of the isthmus a third lobe, called the *pyramidal lobe,* is sometimes found projecting upwards as far as the

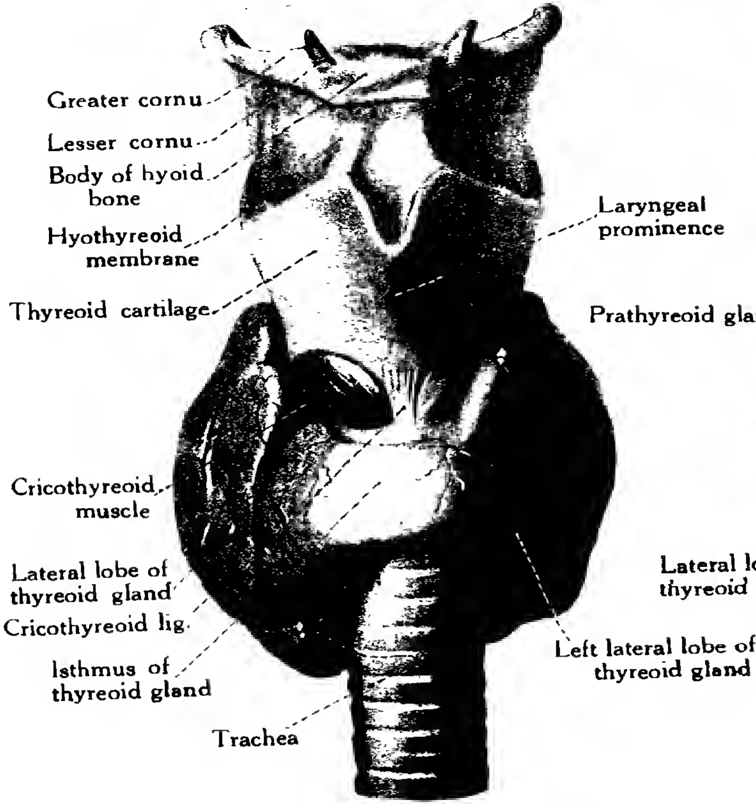

Fig. 94.—The Thyreoid gland. Anterior aspect.

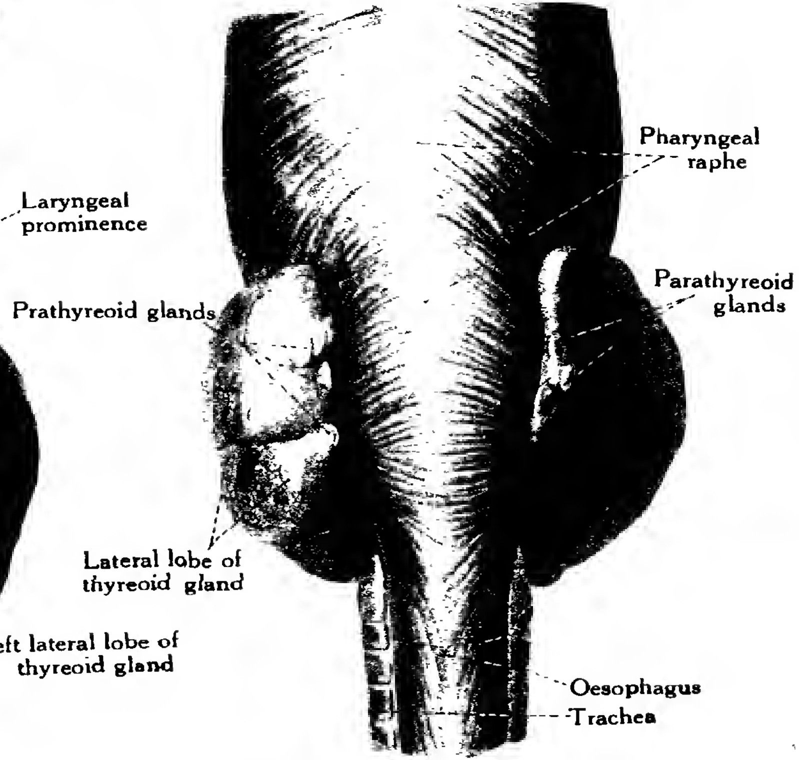

Fig. 95.—The Parathyreoid glands. Posterior aspect.

(Sobotta)

To face P. 3[illegible]

Fig. 96.—Dissection of the infratemporal region (Sobotta).

hyoid bone. Its base is continuous with the isthmus; its apex is attached to the hyoid bone by fibrous tissue or by a band of muscular fibres called the *levator glandulæ thyreoideæ.* This muscle may be attached above to the hyoid bone and below to the isthmus of the gland quite independently of the pyramidal lobe.

Blood-vessels of the thyreoid gland.—The arteries supplying the gland are the branches of the superior and inferior thyreoid arteries and occasionally the thyreoidea ima. These have been already examined. The veins arise from a plexus on the surface of the gland and also from its substance and are three in number: (1) The superior thyreoid vein opens into the internal jugular; (2) the inferior thyreoid vein joins its fellow of the opposite side to form a common trunk and ends in the left innominate vein; and (3) the middle thyreoid vein ends in the internal jugular.

The **Parathyreoid Glands** (Fig. 95) are small oval bodies of a reddish brown colour situated at the posterior borders of the lateral lobes of the thyreoid gland. They are usually four in number, two being connected with each lateral lobe, and lie under cover of the pretracheal fascia. Of these two the superior one is usually placed at the posterior border of the lateral lobe on a level with the cricoid catilage and the inferior one at the lower end of the posterior border.

Trachea.—The thoracic portion of this tube has been described (p. 179). The *cervical portion* extends from the cricoid cartilage to the upper border of the manubrium sterni. It is covered in front by the isthmus of the thyreoid gland, the inferior thyreoid veins, the thyreoidea ima artery (when present), the innominate artery at the root of the neck, the sterno-hyoid and sterno-thyreoid muscles, the pretracheal layer of fascia colli and the connecting branch between the anterior jugular veins of the two sides. Behind, it rests on the œsophagus. On either side are the common carotid artery, the lateral lobe of the thyreoid gland and the recurrent nerve (lying between it and the œsophagus).

The **Œsophagus or Gullet** is a muscular tube extending from the lower end of the pharynx to the stomach. Its *thoracic portion* has been described (p. 182). Its *cervical portion* begins at the level of the lower border of the cricoid cartilage. At its commencement it lies in the middle line and then inclines to the left. The trachea lies in front of it, while behind it rests upon

the prevertebral muscles. Laterally it is in relation with the common carotid artery (specially on the left side) and the lateral lobe of the thyreoid gland.

TEMPORAL AND INFRATEMPORAL REGIONS

The dissection of these regions comprises an examination of :—1. The masseter, temporal, and external and internal pterygoid muscles. 2. The internal maxillary artery and its branches, pterygoid plexus of veins and internal maxillary vein. 3. The mandibular nerve and its branches.

The **Masseter** is quadrilateral in shape. It consists of two portions, superficial and deep. The *superficial portion* arises from the lower border of the anterior two-thirds of the zygomatic arch ; the *deep portion* arises from the posterior third of the lower border and the whole length of the medial surface of the zygomatic arch. The fibres of the superficial portion pass downwards and backwards and those of the deep portion pass downwards and forwards. The muscle is inserted into the lateral surfaces of the coronoid process and the entire ramus of the mandible. The masseteric branch of the mandibular nerve enters the deep surface of the muscle to supply it and will be seen when the muscle is reflected. The masseter pulls the mandible against the maxillæ as is required in the mastication of food.

The **Temporal Fascia** is a strong aponeurosis covering the temporal muscle. Above it is attached to the whole extent of the superior temporal line. The upper margin of the fascia was detached by the dissector when the skull cap was sawn. Below it divides into two layers of which the superficial layer is attached to the upper border and the deep layer to the upper part of the medial surface of the zygomatic arch. If the superficial layer of the temporal fascia is divided close to the zygomatic arch the zygomatico-temporal branch of the superficial temporal artery, the zygomatico-temporal branch of the maxillary nerve and a small quantity of fat will be seen to lie between the two layers. From the deep surface of the fascia the superficial fibres of the temporal muscle take their origin.

Dissection. The temporal muscle should now be fully exposed. Divide the zygomatic arch first in front near its junction with the zygomatic bone and then behind near the external acoustic meatus and turn the arch downwards with the masseter attached to it ; dissect out the masseteric vessels and nerve

which cross the mandibular notch to enter the deep surface of the muscle. Next clean the surface of the temporalis.

The **Temporalis** (Temporal muscle) arises from the entire extent of the temporal fossa (except that part of it which is formed by the zygomatic bone) and from the deep surface of the temporal fascia. Its fibres converge into a strong tendon which is inserted into the summit, anterior border and medial surface of the coronoid process and into the anterior border of the ramus of the mandible, extending downwards nearly to the last molar tooth. It is supplied by the mandibular nerve. It raises the mandible and presses it against the maxillæ.

Dissection. The coronoid process is to be sawn off by a cut which should be commenced at the centre of the mandibular notch and carried downwards and forwards to a point near the last molar tooth, so as to include the insertion of the temporalis. Reflect it upwards with the temporal muscle, which should be detached by the handle of the knife from the lower part of the temporal fossa. Dissect out the buccinator nerve and artery which run downwards and forwards beneath the temporalis. Next to obtain a good view of the structures of the infratemporal region remove a portion of the ramus of the mandible by sawing through the neck of the bone and by another horizontal cut just above the mandibular foramen (Fig. 96). While using the saw in the latter situation protect the soft parts on the medial aspect of the ramus by a piece of cloth inserted between the soft parts and the bone and pull down the soft parts with the piece of cloth as low as the mandibular foramen through which the inferior alveolar vessels and nerves are entering. When the loose piece of bone is removed and the subjacent parts are cleaned the external and internal pterygoid muscles are brought into view; the former passes backwards to the neck of the mandible while the latter proceeds downwards on the deep surface of the external pterygoid towards the inner aspect of the angle of the mandible. Taking the external pterygoid muscle as guide search for the vessels and nerves in this region. Along the upper border of the muscle look for the masseteric nerve entering the deep surface of the masseter and the two deep temporal nerves together with the two deep temporal arteries entering the temporal muscle. Along the lower border of the muscle look for the lingual and inferior alveolar nerves which emerge from beneath the lower border of the muscle, the former being the anterior of the two; along the superficial surface of the muscle the internal maxillary artery

passes upwards and forwards and distributes its branches; sometimes the artery is placed beneath the muscle. Trace the buccinator nerve and artery at the fore part of the muscle issuing between its two heads and passing downwards and forwards.

The **Pterygoideus Externus** (External pterygoid muscle), triangular in shape, arises by two heads, an upper and a lower. The *upper head* arises from the infratemporal ridge and infratemporal surface of the great wing of the sphenoid; the *lower head* arises from the lateral surface of the lateral pterygoid lamina of the sphenoid. From this origin the muscle passes horizontally backwards to be inserted into the depression (pterygoid fovea) on the anterior surface of the neck of the mandible and into the anterior margin of the articular disc of the temporo-mandibular articulation. It is supplied by a branch from the mandibular nerve. It helps in opening the mouth by drawing the condyle forwards while the depression of the mandible is effected by the suprahyoid muscles; if both muscles act, the mandible is carried directly forwards.

The **Pterygoideus Internus** (Internal pterygoid muscle), quadrilateral in shape, arises (1) from the medial surface of the lateral pterygoid lamina, (2) from the grooved posterior surface of the pyramidal process of the palatine bone, (3) from the lateral surface of the same process, and (4) from the tuberosity of the maxilla. The muscle passes downwards, backwards and lateralwards and is inserted into the lower and back part of the medial surface of the ramus, extending from the mandibular foramen to the angle of the mandible. It is supplied by a branch from the mandibular nerve. It raises the mandible and by the alternate action of the pterygoid muscles of the two sides the trituration of the food is effected.

The **Mandibular Joint** should now be studied. It is a ginglymus or hinge-joint. The parts entering into the formation of the joint are the articular tubercle (eminentia articularis) and the anterior portion of the glenoid fossa of the temporal bone above and the condyle of the mandible below. The following are the ligaments of the joint:—

(1) The *articular capsule* is attached above around the articular surface of the mandibular fossa and to the anterior margin of the articular tubercle; below, to the neck of the mandible.

(2) The *temporo-mandibular ligament* (external lateral ligament) is attached above to the lateral surface of the zygomatic

process of the temporal bone and to the tubercle at the root of the zygoma. The ligament passes downwards and backwards to be attached below to the lateral aspect of the neck of the mandible.

(3) The *spheno-mandibular ligament* (internal lateral ligament) extends from the spina angularis of the sphenoid above to the lingula of the mandible below. It is in reality a thickened band derived from the process of the fascia colli which passes beneath the parotid gland. Its lateral surface is in relation, above, with the external pterygoid muscle and auriculo-temporal nerve; lower down, with the internal maxillary vessels which pass between it and the neck of the mandible; still lower, the inferior alveolar vessels and nerve pass between it and the ramus of the mandible.

(4) The *stylo-mandibular ligament* extends from the styloid process of the temporal bone to the angle and adjoining posterior border of the ramus of the mandible. It is also a thickened band derived from the process of the fascia colli which passes beneath the parotid gland.

To expose the articular disc divide the capsule close to the temporal bone and remove the temporo-mandibular ligament. While dividing the capsule care should be taken of the auriculo-temporal nerve which lies close to it medially.

(5) The *articular disc* is an oval fibro-cartilaginous plate interposed between the articular surfaces; it divides the joint cavity into two parts. Its upper surface is concavo-convex and fits into the articular tubercle and mandibular fossa. Its lower surface is concave and is moulded to the convexity of the condyle of the mandible. Its circumference is attached to the surrounding articular capsule. Its anterior border gives attachment to the tendon of the pterygoideus externus.

Synovial stratum.—There are two synovial strata: one lines the upper surface of the disc and the part of the articular capsule above it; the other lines the lower surface of the articular disc and the part of the articular capsule below it.

Movements.—The movements permitted in the mandibular joint and the muscles producing these movements may be described as follows:—(1) *elevation,* caused by masseter, temporal and internal pterygoid; (2) *depression,* produced by digastric, mylohyoid, geniohyoid and external pterygoid; (3) *protrusion,* caused by external and internal pterygoid muscles of both sides; (4) *retraction,* produced by the posterior fibres of the temporal

and deep fibres of masseter ; (5) *side to side* movement as in chewing caused by external and internal pterygoid muscles of one side.

Dissection The condyle of the mandible is now to be disarticulated and thrown forwards with the pterygoideus externus attached to it. The internal maxillary artery and its branches are then to be cleaned and studied.

The **Internal Maxillary Artery** is the larger terminal branch of the external carotid artery. It arises behind the neck of the mandible in the substance of the parotid gland and is usually divided into three portions. The *first portion* (mandibular part) proceeds forwards between the neck of the mandible and the spheno-mandibular ligament being placed along the lower border of the pterygoideus externus. The *second portion* (pterygoid part) runs obliquely upwards and forwards on the superficial surface of the pterygoideus externus (sometimes on the deep surface of the muscle), being placed under cover of the temporal muscle. The *third portion* (pterygopalatine part) passes medialwards between the two heads of the pterygoideus externus to enter the pterygo-palatine fossa.

The *branches* of the artery are classified into three sets :—

From the 1st *part*	From the 2nd *part*	From the 3rd *part*
1. Anterior tympanic.	1. Deep temporal.	1. Posterior superior alveolar.
	2. Pterygoid.	
2. Deep auricular.	3. Masseteric.	2. Infraorbital.
3. Middle meningeal.	4. Buccinator.	3. Descending palatine.
4. Accessory meningeal.		4. Artery of the pterygoid canal.
5. Inferior alveolar.		5. Pharyngeal.
		6. Sphenopalatine.

The *anterior tympanic artery* passes upwards behind the mandibular joint and enters the tympanic cavity through the petro-tympanic fissure (Glasserian fissure). It supplies the tympanic membrane and anastomoses with the stylomastoid artery on its surface.

The *deep auricular artery* passes upwards through the parotid gland behind the mandibular joint and pierces the anterior wall of the external acoustic meatus to supply the skin lining it.

The *middle meningeal artery* passes upwards along the medial surface of the external pterygoid muscle between the two roots of the auriculo-temporal nerve. It enters the cranial cavity

through the foramen spinosum. Its course and branches in the cranial cavity have been examined (p. 216).

The *accesory meningeal artery* arises sometimes from the middle meningeal. It enters the cranial cavity through the foramen ovale. Its distribution in the cranial cavity has been examined (p. 217).

The *inferior alveolar artery* (inferior dental artery) passes downwards and forwards accompanied by the inferior alveolar nerve and enters the mandibular foramen. It then traverses the mandibular canal with the nerve of the same name and will be examined when the canal is laid open. Before entering the mandibular foramen it gives off two branches : (1) the *lingual branch* which descends with the lingual nerve and supplies the mucous membrane of the mouth ; (2) the *mylohyoid artery* which passes downwards and forwards in the mylohyoid groove with the nerve of the same name and ramifies on the superficial surface of the mylohyoid muscle.

The *deep temporal arteries* are two in number, anterior and posterior, which ascend between the pericranium and the temporal muscle. They supply the muscle and anastomose with the middle temporal artery.

The *pterygoid branches* are given off to the external and internal pterygoid muscles.

The *masseteric artery* crosses the mandibular notch with the nerve of the same name and enters the deep surface of the masseter muscle.

The *buccinator artery* runs forwards with the buccinator nerve to the outer surface of the buccinator muscle. It supplies the muscle and anastomoses with the branches of the external maxillary artery.

The *posterior superior alveolar artery* (posterior dental artery) is the only branch of the third part of the internal maxillary artery which can be examined now. It descends upon the infratemporal surface of the maxilla and divides into many minute branches ; some of which enter the alveolar canals to supply the lining membrane of the maxillary sinus and the upper molar and premolar teeth ; while others supply the gums.

The remaining branches of the third portion of the internal maxillary artery will be examined during the dissection of the pterygo-palatine fossa.

The **Pterygoid Plexus of Veins** and the **Internal Maxillary Vein** (**Fig. 96**).—Around the external pterygoid muscle is seen, a

plexus of veins called the *pterygoid plexus* into which the tributaries corresponding to the branches of the internal maxillary artery open. From this plexus proceeds a short venous trunk called the *internal maxillary vein* which accompanies the first portion of the internal maxillary artery. Passing through the parotid gland it unites behind the neck of the mandible with the superficial temporal vein to form the posterior facial vein (temporo-maxillary vein). The pterygoid plexus communicates above with the cavernous sinus by emissary veins which pass through the foramen ovale, the foramen Vesalii and the foramen lacerum. In front it communicates with the anterior facial vein by the *deep facial vein* which proceeds forwards beneath the masseter muscle to join the anterior facial vein. It also communicates with the inferior ophthalmic vein in the orbit by a small branch which passes through the inferior oribital fissure.

Dissection. As the pterygoideus externus has now been reflected, the student should proceed to examine the mandibular nerve and its branches. The chord tympani nerve, a branch of the facial, should also be found out—to secure it the lingual nerve is to be pulled forwards and the chorda tympani will be seen to join the posterior border of the lingual nerve at an acute angle about three quarters of an inch below the skull, after passing to the medial side of the inferior alveolar nerve.

The **Mandibular Nerve** (Inferior maxillary nerve) is the largest of the three divisions arising from the semilunar ganglion of the trigeminal nerve. It differs from the other two divisions in containing both motor and sensory fibres. The motor root of the trigeminal nerve comes out of the cranial cavity in company with the third division of the semilunar ganglion (which consists of sensory fibres only) through the foramen ovale. The motor and sensory portions unite with each other either inside the foramen or just after their exit from it to form the mandibular nerve. The mixed nerve trunk lies under cover of the external pterygoid muscle and immediately divides into an anterior and a posterior division. Prior to the division, two branches, viz., the nervus spinosus and the nerve to the pterygoideus internus are given off from the main trunk.

The *nervus spinosus* (recurrent branch) enters the cranial cavity through the foramen spinosum with the middle meningeal artery. Its distribution has been examined (p. 219).

The *nerve to the pterygoideus internus* is a slender branch which passes forwards to enter the deep surface of the internal

pterygoid muscle. It gives off one or two filaments which constitutes the motor root of the otic ganglion.

The anterior division (nervus masticatorius) of the mandibular nerve is the smaller of the two divisions. It contains motor and sensory fibres and divides into branches which supply the muscles of mastication and the skin and mucous membrane of the cheek. It gives off the following branches :—(1) masseteric, (2) deep temporal, (3) external pterygoid and (4) buccinator.

The *masseteric nerve* passes above the pterygoideus externus and crosses the mandibular notch with the artery of the same name to enter the deep surface of the masseter.

The *deep temporal nerves* are two in number, an anterior and a posterior. They run upwards above the pterygoideus externus and enter the deep surface of the temporal muscle.

The *nerve to the pterygoideus externus* enters the deep surface of the muscle ; it generally arises in common with the buccinator nerve.

The *buccinator nerve* (long buccal nerve) runs forwards between the two heads of the external pterygoid muscle and then downwards under cover of the temporal muscle. Emerging from beneath the anterior border of the masseter it lies on the superficial surface of the buccinator and communicates with the buccal branches of the facial nerve forming the *buccal plexus*. Filaments from the plexus supply the skin and the mucous membrane of the cheek. A *temporal branch* is given off from this nerve after its passage through the external pterygoid muscle and enters the deep surface of the temporal muscle.

The posterior division of the mandibular nerve contains mainly sensory fibres but receives some fibres from the motor root also. It divides into three branches (1) auriculotemporal, (2) lingual and (3) inferior alveolar.

The *auriculo-temporal nerve* arises by two roots between which the middle meningeal artery passes. It runs backwards under cover of the pterygoideus externus to the neck of the mandible. It then proceeds upwards in company with the superficial temporal artery between the auricula and the condyle of the mandible under cover of the parotid gland. Crossing the posterior part of the zygomatic arch it reaches the temporal region where it has been studied (p. 200). Its branches are :—(1) *Communicating branches* to the otic ganglion and facial nerve. Two twigs from the otic ganglion join the two roots of the nerve ; the two filaments to the facial nerve pass forwards to join that

nerve at the posterior border of the masseter muscle. (2) The *articular branches* are one or two twigs which enter the mandibular joint. (3) The *parotid branches* supply the parotid gland. (4) The *auricular branches* are usually four in number: two of them supply the skin of the external acoustic meatus by passing through the bony and cartilaginous portions of the canal; the other two filaments supply the skin of the upper and front part of the auricula. (5) The *temporal branches* accompany the superficial temporal artery and supply ths skin of the temporal region.

The *lingual nerve* is purely sensory. It lies under cover of the external pterygoid muscle and is joined in this situation at an acute angle by the chorda tympani nerve. Emerging from the lower border of the muscle it lies in front of and medial to the inferior alveolar nerve, runs downwards and forwards between the ramus of the mandible and the internal pterygoid muscle and reaches the submaxillary region. Its further course will be studied later on.

The *inferior alveolar nerve* (inferior dental nerve) is the largest branch of the mandibular nerve. It is chiefly sensory but also contains some motor fibres. Emerging from the lower border of the external pterygoid muscle behind the lingual nerv , it runs downwards to enter the mandibular foramen in company with the inferior alveolar artery. The motor fibres contained in the inferior alveolar nerve quit it just before its entrance into the mandibular foramen and constitute the mylohoid nerve. The *mylohoid nerve* runs along the mylohyoid groove of the mandible in the submaxillary triangle where it supplies the mylohyoid muscle and the anterior belly of the digastricus. Besides the mylohyoid branch the inferior alveolar nerve gives off other branches inside the mandibular canal. To expose these branches remove the lateral wall of the mandibular canal by a chisel so that the canal is opened up properly. The branches given off within the canal are: (1) *dental branches* which supply the molar and premolar teeth, (2) *incisive branch* which supplies the canine and incisor teeth; (3) *mental branch* which emerges through the mental foramen and communicates with the mandibular branch of the facial nerve.

As the mandibular canal has now been laid open, the *inferior alveolar artery* can be seen to traverse the canal. It supplies dental branches to each of the molar and premolar teeth and divides into an incisor and a mental branch. The incisor branch

supplies twigs to the canine and incisor teeth and passes forwards to the symphysis menti. The mental branch issues through the mental foramen and appears on the face where it has been examined.

Chorda Tympani Nerve.—A portion of this nerve in the infratemporal region is now seen. It issues out of the petrous portion of the temporal bone through a slit at the medial end of the petro-tympanic fissure (canal of Huguier). It is joined by a filament from the otic ganglion and runs downwards and forwards under cover of the external pterygoid muscle and unites with the lingual nerve at an acute angle.

DEEP DISSECTION OF THE SUBMAXILLARY REGION

Dissection. The superficial dissection of the submaxillary region has been finished (p. 284). The student should now proceed with the deep dissection of this region. The position of the head and of the neck is the same as for the dissection of the anterior triangle of the neck. Detach the anterior belly of the digastricus from the mandible. Dislodge the submaxillary gland from beneath and fix it with hooks backwards. The *submaxillary lymph glands*, usually four to six in number, which lie on the surface of the submaxillary gland are to be removed. The mylohyoid muscle is now fully exposed ; its surface is to be cleaned. Next divide the external maxillary artery and the anterior facial vein over the mandible and throw them downwards. Note the mylohyoid nerve on the surface of the mylohyoid muscle ; it supplies the muscle and also the anterior belly of the digastricus.

The **Mylohyoid Muscle,** triangular in shape, arises from the whole length of the mylohyoid line of the mandible. The posterior fibres proceed medialwards and downwards and are inserted into the anterior surface of the body of the hyoid bone. The middle and anterior fibres pass downwards, forwards and medialwards to be inserted into a fibrous raphe extending from the symphysis menti to the body of the hyoid bone. The muscles of both sides together form what is called the *diaphragm of the cavity of the mouth.* It is supplied by the mylohyoid branch of the inferior alveolar nerve which runs along its surface. It depresses the front of the mandible ; its chief action is to elevate the hyoid bone and tongue during deglutition.

Dissection. Divide the mylohyoid muscle near its attachment to the mylohyoid line, taking care that the mucous mem-

brane of the mouth is not injured and separate the muscle from its fellow of the opposite side by a vertical cut through the median raphe. Reflect the muscle downwards. Next saw through the mandible a little lateral to the symphysis menti (without injuring the attachments of the genioid muscles) and fix the loose portion of the mandible upwards with hooks. This dissection brings into view the *structures covered by the mylohyoid muscle.* These are :—(1) mucous membrane, extending between the medial surface of the mandible and the tongue. (2) The hyoglossus stretches from the hyoid bone to the side of the tongue. (3) The styloglossus lies superficial to the upper part of the hyoglossus. (4) The geniohyoid and genioglossus are seen anterior to the hyoglossus. (5) The sylohyoid ligament passes beneath the posterior border of the hyoglossus. (6) On the superficial surface of the hyoglossus are placed from above downwards the lingual nerve, the submaxillary ganglion, the deep portion of the submaxillary gland with the submaxillary duct, hypoglossal nerve and its vena comitans ; one or two loops formed by the communicating branches of the lingual and hypoglossal nerves are seen near the anterior border of the muscle. (7) The sublingual gland with its artery lies upon the genioglossus. (8) The glosso-pharyngeal nerve is placed below the stylo-glossus and passes beneath the posterior margin of the hyoglossus. (9) The lingual artery passes under cover of the hyoglossus and is placed near the hyoid bone.

The **Submaxillary Gland** consists of two portions, a superficial and a deep. The *superficial portion* lies superficial to the mylohyoideus. Its *anterior border* lies against the anterior belly of the digastricus. Its *posterior border* is grooved to accommodate the external maxillary artery and is separated from the parotid gland by the stylomandibular ligament. The surfaces of the superficial portion of the gland are three in number. The *lateral surface* lies against the fossa for it on the body of the mandible and on the deep surface of the lower part of the pterygoideus internus. The *medial surface* lies against the mylohyoideus, hyoglossus, stylohyoideus, styloglossus and the posterior belly of the digastricus. From this surface the deep portion of the gland passes forwards under cover of the mylohyoideus. The *inferior surface* is covered by the submaxillary lymph glands and is crossed posteriorly by the anterior facial vein. The *deep portion* of the submaxillary gland projects forwards between the mylohyoideus and the hyoglossus as far as the sublingual

gland between the lingual nerve with the submaxillary ganglion above and the hypoglossal nerve with its vena comitans below.

The *submaxillary duct* (Wharton's duct) is about two inches (5. c.m.) in length and arises by several branches from the medial surface of the superficial portion and from the deep portion of the gland. It proceeds forwards and upwards along the inferior surface of the hyoglossus muscle between the lingual nerve lying above and the hypoglossal nerve below it. Then it runs on the surface of the genioglossus muscle where it is crossed by the lingual nerve. Finally it passes between the last named muscle and the sublingual gland and opens on the summit of a papilla close to the frenulum linguæ.

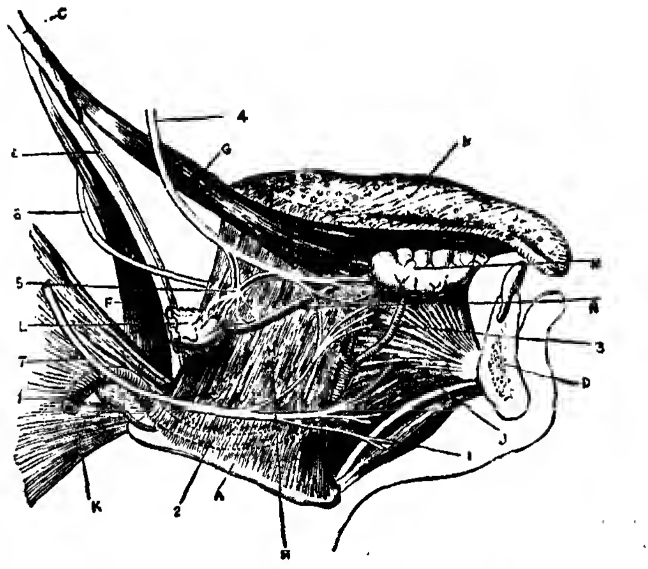

Fig. 97.—Dissection of the submaxillary region (Cunningham).

A. Hyoid bone.
B. Tongue.
C. Styloid process.
D. Symphysis menti.
E. Stylo-hyoid ligament.
F. Stylo-pharyngeus.
G. Stylo-glossus.
H. Hyo-glossus.
I. Genio-hyoid.
J. Genio-glossus.
K. Middle constrictor of pharynx.
L. Deep portion of submaxillary gland.
M. Sublingual gland.
N. Submaxillary duct.
1. Lingual artery.
2. The same, under cover of the hyoglossus.
3. Sublingual artery.
4. Lingual nerve.
5. Submaxillary ganglion.
6. Glosso-pharyngeal nerve.
7. Hypoglossal nerve.

The **Sublingual Gland** is an almond shaped body and is the smallest of the salivary glands. Above it, is the raised fold of the mucous membrane of the floor of the mouth, called the *plica sublingualis*. Below it rests on the upper surface of the mylohyoid muscle. Laterally it lies against a fossa on the inner surface of the body of the mandible close to the symphysis menti. Medially it is in relation with the genioglossus muscle ; the lingual nerve and the submaxillary duct separate it from the muscle. Behind it is in relation with the deep portion of the submaxillary gland. Its *ducts* (ducts of Rivinus) are eight to twenty in number. Some of them open into the submaxillary duct ; others open into the floor of the mouth on the plica sublingualis.

The **Hyoglossus** is a quadrilateral muscle which arises from the anterior surface of the body of the hyoid bone and from the whole length of its greater cornu. Its fibres proceed upwards to be inserted into the side of the tongue medial to the insertion of the styloglossus with which its fibres decussate. It is supplied by the hypoglossal nerve. It depresses the tongue.

The **Styloglossus** arises from the anterior aspect of the terminal part of the styloid process and the upper part of the stylohyoid ligament. It is inserted into the side of the tongue as far forwards as its tip ; some of its fibres overlap and decussate with the fibres of the hyoglossus. It is supplied by the hypoglossal nerve. It draws the tongue backwards and upwards.

The **Geniohyoideus** arises from the inferior mental spine on the inner aspect of the symphysis menti and is inserted into the body of the hyoid bone just above the insertion of the mylohyoid muscle. It is supplied by the hypoglossal nerve. It either depresses the mandible or raises the hyoid bone according to its action from below or above.

The **Genioglossus** is a fan-shaped muscle which arises from the superior mental spine behind the symphysis of the mandible. From this origin the fibres radiate and are inserted (1) into the under surface of the tongue close to the middle line extending from the tip to the base of the organ, (2) into the body of the hyoid bone above the insertion of the geniohyoid, and (3) into the wall of the pharynx blending with its middle constrictor muscle. It is supplied by the hypoglossal nerve. It protrudes the tip of the tongue and by the simultaneous action of the two entire muscles the tongue is depressed and hollowed in the middle.

The **Lingual Nerve** has been traced to the point where it lies between the internal pterygoid muscle and the ramus of the

mandible (p. 310). It then proceeds forwards over the constrictor pharyngis superior and reaches a point below the last molar tooth. It continues its forward course along the side of the tongue and crosses the styloglossus, the hyoglossus, and the submaxillary duct and reaches the tip of the tongue being covered only by the mucous membrane. It gives off *communicating branches* to the submaxillary ganglion and to the hypoglossal nerve. The latter form one or two loops near the anterior border of the hyoglossus. The *branches of distribution* supply the mucous membrane of the mouth, the gums and the sublingual gland ; some branches go to supply the mucous membrane and the papillæ over the anterior two-thirds of the tongue by piercing the substance of the organ.

Dissection. Pull the lingual nerve upwards and trace the two filaments descending from it towards the deep part of the submaxillary gland These filaments will lead to the submaxillary ganglion which they join.

The **Submaxillary Ganglion** is a very small ganglion placed upon the hyoglossus muscle between the lingual nerve and the deep portion of the submaxillary gland. It appears to be suspended from the lingual nerve by two filaments, an anterior and a posterior. The posterior filament carries to the ganglion parasympathetic fibres from the chorda tympani branch of the facial nerve and also sensory fibres from the lingual proper. The anterior filament is regarded as a branch given off from the ganglion to the lingual nerve for distribution to the sublingual gland. Thus the *parasympathetic root* of the ganglion is derived from the chorda tympani and the *sensory root* from the lingual. The *sympathetic root* of the ganglion is derived from the plexus around the external maxillary artery. From the ganglion branches are supplied to the submaxillary gland and its duct, to the sublingual gland and to the mucous membrane of the mouth.

Hypoglossal Nerve.—In the submaxillary region the nerve is seen to run forwards on the superficial surface of the hyoglossus. It is then continued in the substance of the genioglossus as far as the tip of the tongue. In this region it gives off branches to the styloglossus, hyoglossus, geniohyoid, genioglossus and the intrinsic muscles of the tongue. At the anterior border of the hyoglossus it communicates with the lingual nerve forming one or two loops. A vein, called the *vena comitans hypoglossi*, accompanies the hypoglossal nerve ; it begins at the tip of the

tongue and opens into the common facial vein or sometimes into the lingual veins.

Dissection. Reflect the hyoglossus muscle upwards by dividing its attachment to the hyoid bone but keep intact the structure which lie on the superficial aspect of the muscle. The second part of the lingual artery with its branches is exposed.

Lingual Artery.—The *first part* of the artery has been examined (p. 296). The *second part* of the artery runs along the upper border of the greater cornu of the hyoid bone and is placed upon the middle constrictor of the pharynx and under cover of the hyoglossus. Reaching the anterior border of the hyoglossus it ascends to the under surface of the tongue between the genioglossus and hyoglossus muscles ; this constitutes the *third part* of the artery. The *fourth part* of the artery is its continuation forwards to the tip of the tongue along the lateral side of the genioglossus and is known as the arteria profunda linguæ. The *branches* given off from the lingual artery are :—(1) The *hyoid branch* which has been studied (p. 296). (2) *Rami dorsalis linguæ.* These are two or three small branches which arise from the second part of the artery and ascend under cover of the hyoglossus to the back part of the dorsum of the tongue to supply its mucous membrane, the palatine tonsil and the soft palate. (3) The *sublingual artery* arises from the second part of the lingual near its termination under cover of the anterior border of the hyoglossus. It passes forwards and upwards upon the genioglossus which it supplies and ends in the sublingual gland. It sends a twig to anastomose with the artery of the opposite side and also with the submental branch of the external maxillary artery. . (4) The *arteria profunda linguæ* (ranine artery) is the fourth or terminal portion of the lingual artery. It passes to the tip of the tongue with a tortuous course along with the lingual nerve.

The *lingual veins* are the venæ comitantes of the lingual artery. They terminate in the internal jugular vein.

The *stylohyoid ligament* extends from the tip of the styloid process to the lesser cornu of the hyoid bone. It may contain a piece of cartilage or may be partially ossified.

The **Glossopharyngeal Nerve** is seen in the present stage of dissection to emerge from beneath the stylopharyngeus muscle. Winding round that muscle it curves forwards and passes under cover of the hyoglossus to be distributed to the mucous membrane

of the fauces, the sides and dorsum of the tongue and the palatine tonsil.

DEEP DISSECTION OF THE NECK

In this dissection the student has to examine.—I. The stylopharyngeus and rectus capitis lateralis muscles. II. The internal carotid and ascending pharyngeal arteries ; the ascending palatine and tonsillar branches of the external maxillary artery and the internal jugular vein. III. The cervical portion of the sympathetic trunk ; the glossopharyngeal, vagus, accessory and hypoglossal nerves and the first cervical nerve.

Dissection. Divide the posterior belly of the digastric and the stylohyoid muscle near their origin and throw them forwards and downwards, noting the nerve twigs supplying them. Divide the posterior and terminal branches of the external carotid artery and throw the artery forwards. Clean the stylopharyngeus muscle without injuring the glosso-pharyngeal nerve which winds round the lateral side of the muscle and then crosses it.

The **Stylopharyngeus** arises from the medial aspect of the root of the styloid process of the temporal bone and passes downwards and forwards to the side of the pharynx. Its fibres pass between the superior and middle constrictor muscles of the pharynx : some are lost in those muscles ; others are inserted into the posterior border of the corresponding lamina of the thyreoid cartilage. It is supplied by a twig from the glossopharyngeal nerve. It raises the pharynx and thus dilates the cavity of the pharynx.

Dissection, Cut through the base of the styloid process and throw it forwards with the attached muscles. The internal carotid artery and the internal jugular vein will now be seen and they are to be followed upwards to the base of the skull. While cleaning the internal jugular vein note the lymph glands which surround it. These are the superior deep cervical lymph glands. The ascending pharyngeal artery which arises close to the origin of the external carotid artery is to be followed upwards as it ascends between the pharynx and the internal carotid artery. The ascending palatine artery which has been exposed (p. 296) should also be traced upwards. The superior cervical ganglion of the sympathetic, the last four cerebral nerves as they appear between the internal carotid artery and the internal jugular vein close to the skull, the loop between the first and second cervical nerves and the pharyngeal and superior laryngeal

branches of the vagus nerve are to be cleaned in the midst of the dense fascia which surrounds them.

Internal Cartoid Artery.—This vessel commences at the bifurcation of the common carotid and runs almost vertically upwards to enter the carotid canal in the petrous portion of the temporal bone. After its exit from the carotid canal its further course through the cavernous sinus along the carotid sulcus of the sphenoid has been examined (p. 215). Its terminal portion reaches the brain by piercing the dura mater medial to the anterior clinoid process and will be seen during the dissection of the brain. The portion that lies in the neck is called the *cervical portion*; the portion in the carotid canal of the petrous bone, the *petrous portion*; the portion in the cavernous sinus, the *cavernous portion*; and the terminal portion in the brain, the *cerebral portion*; The cervical part of the artery has *in front* the skin, superficial fascia, the platysma, the sterno-cleido-mastoideus, the parotid gland, the stylopharyngeus, the stylohyoideus and the posterior belly of the digastricus. It is crossed by the hypoglossal and glossopharyngeal nerves, the occipital and posterior auricular arteries. *Behind* it lies against the longus capitis and the sympathetic trunk. On its *lateral side* is the internal jugular vein but is separated from the vein near the base of the skull by the glossopharyngeal, vagus, accessory and hypoglossal nerves. On its *medial side* are the pharynx, the palatine tonsil and the ascending pharyngeal artery. No branches are given off from the cervical portion of the artery.

The **Ascending Pharyngeal Artery** is a slender vessel which takes origin from the external carotid near its commencement and runs vertically upwards between the internal carotid artery and the wall of the pharynx. Reaching the base of the skull it divides into meningeal branches. It gives off :—(1) *prevertebral branches* which supply the prevertebral muscles and anastomose with the ascending cervical artery ; (2) *pharyngeal branches* which supply the constrictor muscles of the pharynx ; one of these enters the pharynx above the superior constrictor muscle to supply the soft palate and the palatine tonsil ; (3) *meningeal branches* which enter the cranial cavity through apertures at the base of the skull, viz., the jugular foramen, the foramen lacerum and the hypoglossal canal and supply the duramater ; (4) *inferior tympanic branch* which enters the tympanic cavity through the inferior tympanic canaliculus and anastomoses with other tympanic arteries.

The *ascending palatine artery* arises from the external maxillary artery near its commencement. It ascends between the styloglossus and stylopharyngeus muscles and along the lateral wall of the pharynx to the base of the skull. It gives off two branches ; one of which pierces the superior constrictor of the pharynx ; the other enters the pharynx along the upper border of the muscle ; both supply the soft palate and palatine tonsil.

The *tonsillar branch* of the external maxillary artery ascends along the lateral wall of the pharynx and pierces the superior constrictor muscle to supply the palatine tonsil.

The **Internal Jugular Vein** is the continuation of the transverse sinus, which leaves the cranial cavity through the posterior compartment of the jugular foramen. At its commencement it is joined by the inferior petrosal sinus outside the jugular foramen. Here it presents a dilatation called the *superior bulb.* At first it lies upon the rectus capitis lateralis and behind the internal carotid artery ; the lower four cerebral nerves intervening between the artery and the vein. Then it descends on the lateral side of the artery up to the upper border of the thyreoid cartilage. Below that it lies to the lateral side of the common carotid artery. Throughout its whole course in the neck it is contained within the carotid sheath with the vagus nerve. Finally it unites with the subclavian vein to form the innominate vein behind the medial end of the clavicle. Before its termination it presents another dilatation called the *inferior bulb.* A pair of valves is seen inside the vessel about an inch above its termination. Many lymph glands are found both in front of and behind the vein. These are the *superior deep cervical lymph glands.* They drain lymph from the face, the mouth and tongue, the nasal part of the pharynx, the palate and tonsils and the larynx. Their efferents pass to the inferior deep cervical lymph glands and to the jugular trunk.

Tributaries.—The internal jugular vein receives (1) the inferior petrosal sinus, (2) the common facial, and (3) lingual veins, (4) the pharyngeal, (5) the superior and middle thyreoid veins, (6) sometimes the occipital vein. The thoracic duct opens into the left internal jugular vein at its union with the left subclavian vein and the right lymphatic duct into the right internal jugular vein at its union with the right subclavian vein.

Dissection. The cervical portion of the sympathetic, its three ganglia and their branches have been partly displayed. A very careful dissection is necessary to bring all of them into

view. The superior ganglion will be seen by raising the internal carotid artery and the vagus and hypoglossal nerves ; its several branches are then to be traced. The middle ganglion will be seen close to the inferior thyreoid artery; its branches are to be followed. To display the inferior ganglion first divide the costo-cervical artery near its origin ; then cut through the subclavian artery at the medial border of the scalenus anterior and fix it with hooks medially—the ganglion will be seen close to the neck of the first rib ; its branches are then to be traced.

The **Cervical Portion of the Sympathetic Trunk** consists of three ganglia linked together by intervening nerve cords and is situated behind the carotid sheath. The ganglia are named superior, middle and inferior according to their situation.

The **Superior Cervical Ganglion** lies behind the internal carotid artery and in front of the longus capitis opposite the second and third cervical vertebræ. It is fusiform in shape and about an inch in length. It communicates with (1) the upper four cervical nerves by grey rami communicantes. Hence it may be regarded as formed by the fusion of four ganglia corresponding to these four cervical nerves. It also communicates with (2) the petrous ganglion of the glosso-pharyngeal nerve, (3) the jugular ganglion and ganglion nodosum of the vagus nerve, and (4) the hypoglossal nerve. Its branches of distribution are :—(1) The *internal carotid nerve* which arises from the upper part of the ganglion and accompanies the internal carotid artery to the carotid canal ; this nerve constitutes the upward prolongation into the cranium of the cervical portion of the sympathetic. (2) The *external carotid branches* are several filaments which surround the external carotid artery and form a plexus. From the plexus offsets are prolonged on the branches of the external carotid artery. (3) The *laryngo-pharyngeal branches* pass to the lateral wall of the pharynx and communicates with the pharyngeal branches of the glossopharyngeal and vagus nerves forming the *pharyngeal plexus.* Some filaments join the superior laryngeal branch of the vagus. (4) The *superior cardiac nerve* arises from the superior cervical ganglion by two or more roots. It passes down the neck behind the common carotid artery. The subsequent course of the two nerves then differ. The *right nerve* enters the thorax either in front of or behind the right subclavian artery and terminates in the deep cardiac plexus. The *left nerve* runs in front of the left common carotid artery and joins the superficial cardiac plexus. In the neck the superior cardiac nerve is joined by other

Fig. 98.—Dissection of the neck in which the deeper structures have been displayed (Sobotta).

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filaments from (1) the sympathetic, (2) the external laryngeal, (3) the vagus and (4) the recurrent nerve.

The **Middle Cervical Ganglion,** the smallest of the three ganglia, lies very close to the inferior thyreoid artery opposite the sixth cervical vertebra. It gives off grey rami communicantes to the fifth and sixth cervical nerves. Hence it may be regarded as formed by the fusion of two ganglia corresponding to those two nerves. It gives off (1) *thyreoid branches* which accompany the inferior thyreoid artery to the thyreoid gland and communicate with the external laryngeal and recurrent nerves. (2) The *middle cardiac nerve* passes into the thorax either in front of or behind the right subclavian artery on the right side and on the left side between the left common carotid and subclavian arteries; it terminates in the deep cardiac plexus.

The **Inferior Cervical Ganglion** lies between the transverse process of the seventh cervical vertebra and the neck of the first rib behind the vertebral artery. It may be fused with the first thoracic ganglion. It furnishes *communicating branches* (grey rami communicantes) to the seventh and eighth cervical nerves. Hence it may be regarded as formed by the fusion of two ganglia corresponding to those two nerves. It gives off (1) *vascular branches* which surround the subclavian artery and form a plexus around it and its branches; (2) the *inferior cardiac nerve* which joins the deep cardiac plexus. This ganglion is connected with the middle cervical ganglion by two or more cords. One of these cords passes in front of the subclavian artery and loop round it. This loop is called the *ansa subclavia* (ansa Vieussenii).

Dissection. The condition of the "part" to which the student has so long been engaged in dissection will not permit the tracing of the several minute branches of the last four cerebral nerves at the base of the skull. If the student wants to examine fully these four nerves in the region of the base of the skull, he should obtain a fresh part in which the bone has been softened by immersing in a weak solution of acid and the nerves hardened in spirit. The ring of bone which forms the medial boundary of the jugular foramen is to be removed with a scalpel.

The **Glossopharyngeal Nerve** is lodged in a bony canal within the jugular foramen and here it is enclosed by a tubular sheath of dura mater which separates it from the inferior petrosal sinus in front and the vagus and accessory nerves behind. It leaves the skull and proceeds forwards between the internal jugular vein

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and the internal carotid artery. It then proceeds medialwards and crosses the latter vessel superficially. Thence it passes beneath the styloid process and the stylopharyngeus and winds round that muscle. Its further course has been described (p. 316).

While passing through the jugular foramen two ganglia are noticed in connection with the glossopharyngeal nerve, viz., an upper called the superior ganglion (jugular ganglion) and a lower called the petrous ganglion. The *superior ganglion* is situated in the upper end of the bony canal containing the nerve and gives off no branch. The *petrous ganglion* is much larger and placed at the lower end of the jugular foramen. From the petrous ganglion branches of communication are given off (1) to the superior cervical ganglion of the sympathetic, (2) to the jugular ganglion of the vagus, and (3) to the auricular branch of the vagus. A communicating branch is given off from the glossopharyngeal nerve below the petrous ganglion which pierces the posterior belly of the digastric and joins the facial nerve after its exit from the cranial cavity. The branches of distribution of the glossopharyngeal nerve are :—(1) tympanic, (2) pharyngeal, (3) nerve to the stylopharyngeus, (4) tonsillar, (5) lingual, and (6) carotid.

Directions. To trace the course of the tympanic nerve and other nerves which pass through the petrous portion of the temporal bone, a separate piece of the petrous bone with the nerves attached to it should be taken and immersed at first in spirit to harden the nerves and then in weak acid solution to soften the bony tissue.

The *tympanic nerve* (Jacobson's nerve) arises from the petrous ganglion and reaches the tympanic cavity through a bony canal which is situated in the ridge separating the jugular fossa from the carotid canal on the inferior surface of the petrous bone. Reaching the tympanic cavity it traverses its medial wall and lies in a groove on the surface of the promontory. Here it is joined by two branches, called the *superior* and *inferior carotico-tympanic branches*, which issue from the sympathetic plexus around the internal carotid artery in the carotid canal. These branches enter the tympanic cavity through the bony wall of the carotid canal and join the tympanic branch of the glossopharyngeal nerve on the promontory forming a plexus called the *tympanic plexus*. Emerging from this plexus the tympanic branch then quits the tympanic cavity at its anterior part and passes through a bony canal to enter the middle cranial fossa through a slit just lateral to the hiatus canalis facialis on the anterior

surface of the petrous portion of the temporal bone. In this bony canal it is joined by a filament from the geniculate ganglion of the facial nerve and is then termed the *lesser superficial petrosal nerve*. Its exit from the middle cranial fossa through the foramen ovale or through the canaliculus innominatus or through a slit between the sphenoid and the petrous bone has been seen (p. 219). After its exit from the cranial cavity it ultimately ends in the otic ganglion which will be seen later on. In the tympanic cavity the tympanic nerve supplies filaments to the mucous membrane of the tympanum and of the auditory tube and to the lining membrane of the mastoid cells.

The *pharyngeal branches* are three or four filaments which unite with the pharyngeal branches of the vagus and with the laryngo-pharyngeal branches of the sympathetic trunk to form the *pharyngeal plexus*. Filaments from this plexus supply the muscles of the pharynx and its mucous membrane.

The *nerve to the stylopharyngeus* has been already seen.

The *tonsillar branches* supply the palatine tonsil, the soft palate and the fauces.

The *lingual branches* supply the mucous membrane of the posterior third of the tongue and the anterior surface of the epiglottis.

The *carotid branches* proceed downwards along the internal carotid artery as low as the origin of the vessel.

The **Vagus Nerve** leaves the skull through the middle compartment of the jugular foramen. In the foramen it is contained in the same sheath of dura mater with the accessory nerve and separated from the glossopharyngeal which is enclosed in a separate sheath and is placed in front. After its exit from the foramen the vagus nerve descends vertically within the carotid sheath and lies between the internal carotid artery and the internal jugular vein in the upper part of the neck ; and between the common carotid artery and the same vein in the lower part of the neck. Within the carotid sheath it lies on a plane posterior to the artery and the vein. Finally it enters the thorax on the right side by crossing the first part of the subclavian artery and on the left side by passing between the left common carotid and left subclavian arteries.

Two ganglia are seen in connection with the vagus nerve, viz., an upper or jugular ganglion (ganglion of the root) and a lower or ganglion nodosum (ganglion of the trunk).

The *jugular ganglion* is placed in the jugular foramen. It

gives off twigs which communicate with (1) the petrous ganglion, of the glossopharyngeal nerve, (2) the accessory nerve, and (3) the superior cervical ganglion of the sympathetic. Two branches of distribution arise from the jugular ganglion, viz., the meningeal branch and the auricular nerve. The *meningeal branch* passes upwards through the jugular foramen to supply the dura mater in the posterior fossa of the skull. The *auricular nerve* (Arnold's nerve) is joined by a filament from the petrous ganglion of the glossopharyngeal nerve and passes backwards along the lateral surface of the internal jugular vein to enter the mastoid canaliculus on the lateral wall of the jugular fossa. Then it passes through the substance of the petrous portion of the temporal bone and crosses the facial canal above the stylomastoid foramen where it gives off a twig to communicate with the facial nerve. It then reaches the exterior of the skull by coming out through the tympanomastoid fissure between the mastoid process and the external acoustic meatus and divides into two branches : one of which communicates with the posterior auricular branch of the facial nerve and the other supplies the posterior aspect of the auricula and the external acoustic meatus.

The *ganglion nodosum* is a cylindrical swelling about three-fourths of an inch (2 cm.) in length, developed upon the vagus nerve after its exit from the jugular foramen. The cerebral portion of the accessory nerve joins the ganglion. *Branches of communication* are given off from the ganglion to (1) the superior cervical ganglion of the sympathetic, (2) the loop between the first and second cervical nerves and (3) the hypoglossal nerve. The *branches of distribution* given off from the ganglion nodosum are two in number, the pharyngeal branch and the superior laryngeal nerve. The *pharyngeal branch* passes downwards and forwards crossing the internal carotid artery and enters into the formation of the *pharyngeal plexus*. This plexus is formed by the communication of the pharyngeal branches of the glossopharyngeal, the vagus and the superior cervical ganglion of the sympathetic and supplies the muscles and mucous membrane of the pharynx.

The *superior laryngeal nerve* passes downwards and medialwards behind the internal carotid artery and divides into the external and internal laryngeal nerves. The *external laryngeal nerve* is a long slender filament which passes downwards beneath the sternothyreoid muscle and supplies the cricothyreoideus and the inferior constrictor of the pharynx. The *interal laryngeal*

nerve descends to reach the thyreohyoid membrane which it pierces in company with the superior laryngeal artery to supply the mucous membrane of the larynx and the arytænoideus. It supplies a fine twig to the superior cardiac branch of the sympathetic.

The *branches* given off from the trunk of the vagus nerve in the neck are the recurrent nerve (on the right side only) and the superior cardiac nerves.

The *recurrent nerve* (recurrent laryngeal nerve) on the *right side* arises from the vagus opposite the first part of the subclavian artery. Winding round that vessel it passes upwards and medialwards, and reaching the side of the trachea, it proceeds along the groove between it and the œsophagus to the lower border of the inferior constrictor of the pharynx. The origin of the recurrent nerve on the *left side* below the arch of the aorta and its course inside the thorax have been examined (p. 184). In the neck the left nerve ascends along the groove between the trachea and the œsophagus like the right recurrent nerve. Both recurrent nerves enter the larynx under cover of the lower border of the inferior constrictor of the pharynx to supply all the intrinsic muscles of the larynx except the cricothyreoideus. The branches given off from the recurrent nerve are some cardiac branches to the deep cardiac plexus and twigs to the trachea, œsophagus and the inferior constrictor of the pharynx.

The *superior cardiac branches* of the vagus are two in number, an upper and a lower, on each side. On the *right side* both the upper and lower branches enter the thorax to join the deep cardiac plexus. On the *left side* the upper one joins the deep cardiac plexus and the lower one, the superficial cardiac plexus.

The **Accessory Nerve** (Spinal accessory nerve) consists of two portions, a cerebral and a spinal. In the jugular foramen the cerebral portion unites with the spinal portion ; here it is connected with the jugular ganglion of the vagus by one or two filaments. After its exit from the jugular foramen the cerebral portion quits the spinal portion and joins the ganglion nodosum of the vagus. But most of the fibres of the cerebral portion of the accessory nerve after joining the ganglion nodosum are distributed to the pharyngeal and superior laryngeal branches of the vagus; a few fibres are carried downwards into the trunk of the vagus to be distributed with the recurrent and cardiac nerves. The accessory nerve (consisting of the spinal portion only) passes backwards and downwards usually in front of the internal

jugular vein ; it pierces the sterno-cleido-mastoideus at its upper part and supplies some filaments to it. Its further course in the posterior triangle of the neck and its termination in the trapezius have been described (p. 261).

Hypoglossal Nerve.—The roots of the hypoglossal nerve after piercing the dura mater opposite the hypoglossal canal in two bundles unite to from a single trunk inside the canal. After its exit from the canal it is very deeply placed under cover of the internal jugular vein and the internal carotid artery. It next passes downwards and forwards behind the ganglion nodosum of the vagus with which it is closely connected. Then it proceeds between the internal jugular vein and the internal carotid artery till it reaches the lower border of the posterior belly of the digastric, and windng round the occipital artery, turns transversely forwards to cross the external carotid artery and the first part of the lingual artery.Its subsequent course has been described (p. 315).

The hypoglossal nerve gives off *communicating branches* to (1) the superior cervical ganglion of the sympathetic, (2) the ganglion nodosum of the vagus (sometimes this communication is so intimate that it appears as if the two nerves are united into one mass, (3) the first cervical nerve, (4) the pharyngeal plexus (while it hooks round the occipital artery), and (5) the lingual nerve (near the anterior border of the hyoglossus). The *branches of distribution* are (1) meningeal, (2) descending, (3) thyreohyoid and (4) muscular. The *meningeal branches* are given off in the hypoglossal canal to supply the dura mater in the posterior fossa of the skull. The *descending branch* has been examined (p. 285). The *thyreohyoid branch* is a long slender twig which arises from the hypoglossal nerve near the hyoid bone and supplies the thyreohyoid muscle. The *muscular branches* supply the extrinsic and intrinsic muscles of the tongue.

Dissection. The rectus capitis lateralis, stretching between the transverse process of the atlas and jugular process of the occipital bone, should now be cleaned and examined. At the medial margin of the muscle, the anterior division of the first cervical nerve will be found.

The **Rectus Capitis Lateralis** arises from the upper surface of the tip of the transverse process of the atlas and is inserted into the under surface of the jugular process of the occipital bone. It is supplied by a branch from the anterior division of the first cervical nerve. It inclines the head laterally.

Dissection. Divide the rectus capitis lateralis at its attachment to the transverse process of the atlas and reflect it upwards. The anterior division of the first cervical nerve will be seen to form a loop with the second cervical nerve.

Suboccipital Nerve.—The anterior division of the first cervical or suboccipital nerve appears first above the posterior arch of the atlas and is then directed forwards round the lateral surface of its superior articular process and on the medial side of the vertebral artery. It appears in front at the medial side of the rectus capitis lateralis and descends in front of the transverse process of the atlas to form a loop with the ascending branch of the second cervical nerve. It supplies a twig to the rectus capitis lateralis and from the loop between it and the second cervical nerve branches are given off to the rectus capitis anterior and longus capitis. It is also connected by communicating filaments with the vagus and hypoglossal nerves and with the superior cervical ganglion of the sympathetic.

THE PREVERTEBRAL REGION

This dissection comprises an examination of (1) the muscles found in front of the vertebræ, viz., the longus colli and capitis and the rectus capitis anterior ; (2) the vertebral artery with its companion vein. The prevertebral layer of the deep fascia of the neck can also be fully examined now. An opportunity may be taken to examine the intertransverse muscles (p. 232) and the anterior and posterior divisions of the cervical nerves.

Dissection. Divide the common carotid artery, the internal jugular vein, and the vagus and the sympathetic trunk near the first rib and reflect them all upwards.

The *prevertebral fascia* is a process of the deep fascia of the neck given off from the layer which lines the deep surface of the sterno-cleido-mastoideus. It has been already noted that the prevertebral layer assists in forming the posterior wall of the carotid sheath. It covers the prevertebral muscles and is continuous medially with the fascia of the opposite side behind the pharynx and the œsophagus. Above it is attached to the base of the skull and below it is prolonged into the thorax in front of the longus colli. From the anterior aspect of this fascia another thin lamina is given off which passes medial to the carotid sheath on the surface of the constrictor muscles of the pharynx and is prolonged on to the buccinator. This thin lamina is called the

bucco-pharyngeal fascia. Thus a space is formed between the buccopharyngeal fascia in front and the prevertebral fascia behind. This space, called the *retro-pharyngeal space,* is filled with areolar tissue and is continuous below with the posterior mediastinum of the thorax, but limited above at the base of the skull. The prevertebral fascia is prolonged downwards and lateralwards over the scalene muscles into the posterior triangle of the neck, where it forms the sheath for the brachial plexus and the subclavian vessels. It is further continued beneath the clavicle to form the sheath for the axillary vessels ; it then becomes fixed to the coraco-clavicular fascia.

Dissection. Divide the trachea and the œsophagus near the first rib and draw them forwards till the pharynx is separated from the front of the cervical portion of the vertebral column as high as the base of the skull. Define this part of the base of the skull taking care not to injure the pharynx and the prevertebral muscles. Next divide the periosteum over the basilar part of the occipital bone. The whole breadth of the basilar process extending from one jugular foramen to the other and in front of the hypoglossal canal should then be divided by means of a sharp chisel ; the sharp edge of the chisel is to be adjusted in the interval between the prevertebral muscles behind and the pharynx in front—a block being placed against the base of the skull for the required support. Next turn the head on its side and saw through the skull obliquely downwards and forwards close behind the mastoid process until the jugular foramen is reached. Finally the same saw cut is to be made on the other side of the head. The base of the skull is now divided into two portions, an anterior and a posterior. The anterior part of the skull with the pharynx attached to it should be separately wrapped up with cloth and kept soaked in lotion for future examination. Connected with the posterior part of the skull and the cervical portion of the vertebral column are the prevertebral muscles (Fig. 99) which should now be examined.

The **Longus Colli** extends from the third thoracic vertebra to the atlas and consists of three portions—a middle vertical portion, an upper oblique portion, and a lower oblique portion. The *vertical portion,* the largest of the three, arises from the sides of the bodies of the first three thoracic and last two cervical vertebræ and is inserted into the bodies of the second, third and fourth cervical vertebræ. The *upper oblique portion* arises from the anterior tubercles of the transverse processes of the

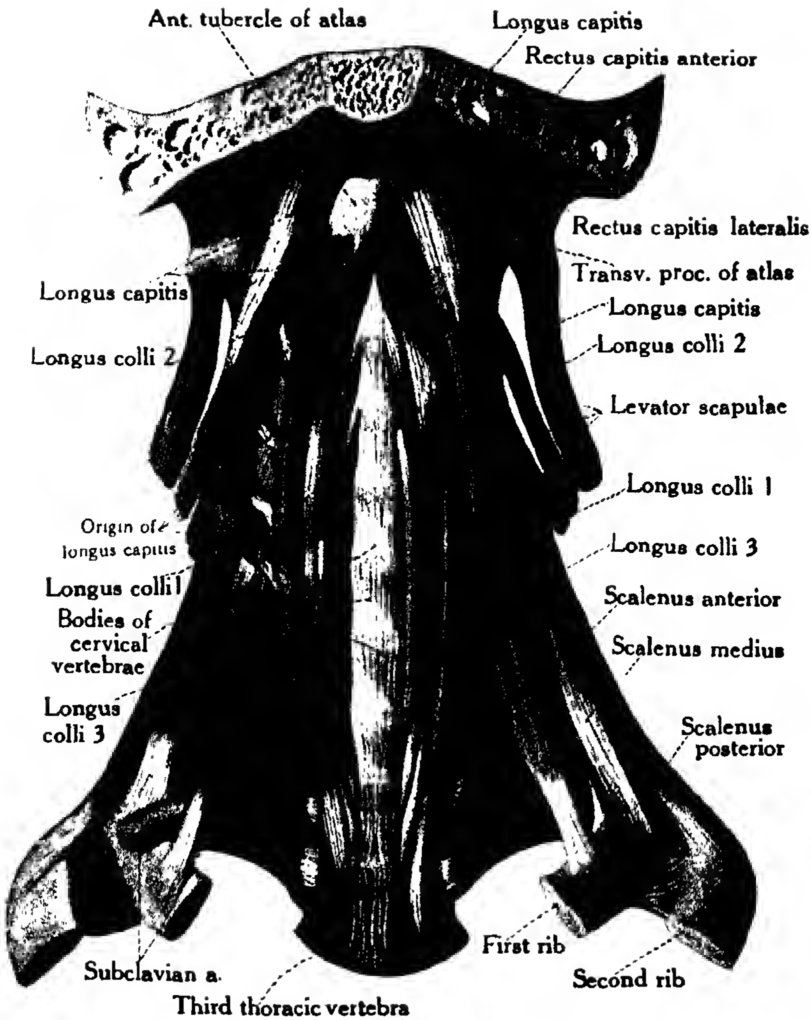

Fig. 99.—The muscles of the prevertebral region (Sobotta)

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third, fourth and fifth cervical vertebræ and is inserted into the tubercle on the anterior arch of the atlas. The *lower oblique portion* arises from the sides of the bodies of the upper two or three thoracic vertebræ and is inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. The longus colli is supplied by branches from the anterior divisions of the cervical nerves. It bends the neck forwards and also lateralwards.

The **Longus Capitis** (Rectus capitis anticus major) arises by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ and is inserted into the inferior surface of the basilar portion of the occipital bone in front of the foramen magnum. It is supplied by branches from the anterior divisions of the first, second and third cervical nerves. It flexes the head.

The **Rectus Capitis Anterior** (Rectus capitis anticus minor) is partly concealed by the longus capitis which should be divided near its insertion and reflected downwards and then the muscle will be fully exposed. It arises from the anterior surface of the lateral mass of the atlas and is inserted into the under surface of the basilar part of the occipital bone behind the insertion of the longus capitis. It is supplied by a twig from the loop between the first and second cervical nerves. It bends the head forwards.

Dissection. The seven pairs of intertransversarii on each side of the cervical region will be seen when the prevertebral and scalene muscles are removed from the front and back of the transverse processes. After the intertransverse muscles and their relations with cervical nerves have been examined, the tips of the transverse processes should be cut off with bone forceps to expose the vertebral artery.

The **Intertransversarii** extend between the transverse processes of the cervical vertebræ. The *anterior intertransverse* muscles pass between the anterior tubercles of two contiguous transverse processes and the *posterior* muscles between the posterior tubercles.

Cervical Nerves..—The anterior divisions of these nerves proceed laterally between the anterior and posterior intertransverse muscles. The posterior divisions pass behind the posterior intertransverse muscles.

The **Vertebral Artery** is usually divided into four parts. The *first part* extends from its origin from the subclavian artery

to the point where it enters the foramen in the transverse process of the sixth cervical vertebra. This part of the vessel has been examined. The artery then ascends through the foramina of the transverse processes of the remaining upper cervical vertebræ constituting its *second part.* The *third part* begins from its exit from the foramen transversarium of the atlas and passes at first backwards and then medialwards around the lateral and posterior aspects of its superior articular process to the groove on the upper surface of the posterior arch of the atlas. This part of the vessel has been examined during the dissection of the suboccipital triangle. The *fourth part* runs upwards and, piercing the dura mater, enters the cranial cavity through the foramen magnum and unites with the artery of the opposite side at the lower border of the pons. The dissector should remember that the vertebral artery has been divided at the lower border of the foramen magnum during the removal of the brain. The union of the two vessels at the lower border of the pons will be noted when the brain will be studied. While passing through the foramina in the transverse processes of the upper six cervical vertebræ it is surrounded by a nerve plexus derived from the inferior cervical sympathetic ganglion and by the vertebral plexus of veins. The *branches* given off from the vertebral artery are: (1) *muscular branches* which supply the deep muscles of the neck; (2) *spinal branches* which enter the vertebral canal through the intervertebral foramina; (3) *meningeal branch,* which is given off before it pierces the dura mater; (4) branches to cerebro-spinal nervous system which will be examined later on.

Vertebral Vein.—There is no companion vein corresponding to the fourth part of the vertebral artery. A venous plexus is formed round the third part of the artery by the union of veins derived from the venous plexus in the suboccipital triangle and the venous plexus in the vertebral canal. This plexus descends through the foramina transversaria of the cervical vertebræ in company with the second part of the artery and ultimately terminates in a single vein which emerges from the foramen in the transverse process of the sixth cervical vertebra. Its subsequent course and termination in the innominate vein have been noted.

ARTICULATIONS OF THE NECK

Cranio-vertebral Articulations.—These consist of the arti-

culation between the occipital bone and the atlas and the articulation between the occipital bone and the epistropheus.

The *articulation between the occipital bone and the atlas* constitutes a pair of condyloid joints, the condyles of the occipital bone articulating with the superior articular processes of the atlas. The following are the ligaments:—(1) The *articular capsules* which are loose and are attached to the margins of the condyles of the occipital bone and the superior articular processes of the atlas. Each capsule is lined by a synovial stratum. (2) The *anterior atlanto-occipital membrane* extends from the anterior margin of the foramen magnum to the upper margin of the anterior arch of the atlas. It is continuous laterally with the articular capsules; it is strengthened in front in the middle line by the continuation upwards of the anterior longitudinal ligament which connects the tubercle in front of the anterior arch of the atlas to the basilar portion of the occipital bone. (3) The *posterior atlanto-occipital membrane* extends from the posterior margin of the foramen magnum to the upper margin of the posterior arch of the atlas. On either side it forms an

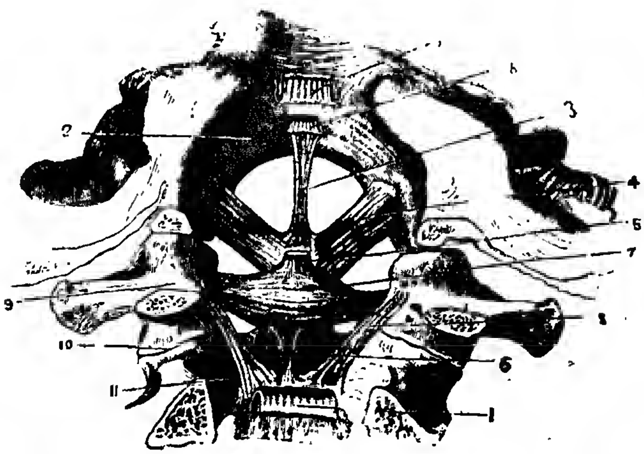


Fig. 100.—Dissection from behind of the ligaments connecting the occipital bone, the atlas and the epistropheus with each other.

1. Membrana tectoria.
2. Occipital bone.
3. Ligamentum apicis dentis.
4. Alar ligament.
5. Crus superius.
6. Crus inferius.
7. Transverse ligament.
8. Accessory atlanto-epistropheal ligament.
9. Lateral mass of atlas.
10. Atlanto-epistropheal joint.
11. Body of epistropheus.

arch over the groove behind the superior articular process of the atlas and bounds an aperture for the entrance of the vertebral artery and the exit of the suboccipital nerve. *Movements.*—Flexion and extension, which constitute the forward and backward nodding movements of the head, take place in this joint.

Articulation between the occipital bone and the epistropheus.—The ligaments connecting these two bones are : (1) The membrana tectoria, (2) the two alar ligaments and (3) ligamentum apicis dentis.

The membrana tectoria (occipito-axial ligament) is contained inside the vertebral canal and may be regarded as the continuation upwards of the posterior longitudinal ligament of the vertebral column to the occipital bone. To expose fully this membrane the posterior arch of the atlas and the vertebral arch of the epistropheus should be divided behind the articular processes and then hooked upwards. It is attached below, by its narrow end, to the posterior surface of the body of the epistropheus, and above by its broad end, to the groove on the basilar part of the occipital bone in front of the foramen magnum.

Dissection. Reflect the membrana tectoria upwards by dividing it at its attachment to the epistropheus. The transverse ligament which binds the dens to the anterior arch of the atlas together with its upper and lower vertical limbs are now exposed. Divide the upper vertical limb which extends from the transverse ligament to the anterior margin of the foramen magnum. The ligamentum apicis dentis and the alar ligaments are now exposed.

The *alar ligaments* (check ligaments) are two strong bands which arise on either side from the summit of the dens and pass upwards and lateralwards to be attached to the medial aspects of the condyles of the occipital bone. Excessive rotation of the head is stopped by the alar ligaments.

The *ligamentum apicis dentis* extends from the summit of the dens to the anterior margin of the foramen magnum and is placed between the alar ligaments.

The *articulation between the atlas and the epistropheus* comprises : (1) the articulation between the dens and the anterior arch of the atlas, which is a pivot joint ; and (2) the articulation between the inferior articular processes of the atlas and the superior articular processes of the epistropheus, which are arthrodial joints. The ligaments connecting these bones are :—

(1) The *anterior longitudinal ligament*. It is the continuation

upwards of the anterior longitudinal ligament of the vertebral column and extends from the anterior surface of the body of the epistropheus to the lower border of the anterior arch of the atlas.

(2) The *ligamenta flava* correspond to the ligamenta flava connecting the vertebral arches and connect the upper borders of the laminæ of the epistropheus to the lower border of the posterior arch of the atlas.

(3) The *articular capsules* are loose and surround the inferior articular processes of the atlas and the superior articular processes of the epistropheus. Each capsule is lined by a synovial stratum and strengthened by an accessory ligament extending from the posterior aspect of the base of the dens to the posteromedial aspect of the lateral mass of the atlas.

(4) The *transverse ligament of the atlas* stretches across the ring of the atlas and is attached on either side to a tubercle on the medial aspect of the lateral mass of the bone. It holds the dens in contact with the anterior arch of the atlas.

Opposite the posterior surface of the dens a vertical limb, called the *superior crus*, passes upwards to the anterior margin of the foramen magnum and another vertical limb, called the *inferior crus*, passes downwards to the posterior surface of the body of the epistropheus. The superior crus has been already cut and reflected to expose the ligamentum apicis dentis. If the superior crus is replaced, the transverse ligament with its two vertical limbs will be seen to constitute what is called the *ligamentum cruciatum atlantis*.

There is a *synovial stratum* between the anterior surface of the dens and the anterior arch of the atlas and another between the posterior surface of the dens and the transverse ligament.

Movements.—The three joints which constitute this articulation allow rotation of the head—the atlas and head moving together round the pivot formed by the dens. Excessive rotation is stopped by the alar ligaments.

The articulations of the lower five cervical vertebræ and the ligaments connecting them are the same as seen in the thoracic or lumbar region (p. 193).

THE ORBIT

Before commencing the dissection of the orbit, the student should first study the bony orbit, its roof, floor, medial and lateral walls, base, and apex.

The following structures have to be examined in the dissection of the orbit.

I. Muscles.—(1) The levator palpebræ superioris, (2) the four recti muscles and (3) the two obliqui muscles.

II. Vessels.—The ophthalmic artery and its branches and the ophthalmic veins.

III. Nerves.—(1) The oculomotor, trochlear, and abducent nerves ; (2) the three branches of the ophthalmic division of the trigeminal nerve , (3) the zygomatic branch of the maxillary nerve ; and (4) the optic nerve. IV. The ciliary ganglion. V. The lacrimal gland. VI. The fascia bulbi.

Dissection. The cavity of the orbit is to be opened by removing the bone forming its roof. The saw is to be applied through the frontal bone (1) at the medial end of the supraorbital margin and (2) at its articulation with the zygomatic bone. Then with a chisel the saw cuts are to be continued backwards so as to meet near the front of the optic foramen, the bony ring of the foramen being left intact. By a few gentle strokes of the hammer the portion of bone included between these cuts is to be loosened and tilted forwards. The remains of the small wing of the sphenoidal bone and the projecting anterior clinoid process should be cut away with bone forceps. Any small projection of bone if left behind to interfere with the dissection should be removed. And lastly during the dissection of the orbital cavity the eye ball should be drawn forwards and kept in this position by a piece of thread or hooks.

The *periosteum* covering the under surface of the roof of the orbit is now exposed. It is loosely attached to the walls of the orbit and is continuous posteriorly with the dura mater inside the cranial cavity through the superior orbital fissure and the optic foramen. In front it is continuous with the periosteum lining the exterior of the skull. Its connections with the orbital septum have been described (p. 278).

Dissection. The periosteum is to be divided antero-posteriorly along the middle line and transversely close to the supraorbital margin. Reflect the flaps medially and laterally. After some fat has been removed the dissector will observe the lacrimal gland at the lateral and front part of the orbit ; the frontal nerve and the supraorbital artery along the middle line ; the lacrimal nerve and artery on the lateral side ; and the trochlear nerve on the medial side ; the levator palpebræ lying upon the superior rectus along the middle line ; the superior oblique muscle on the

medial side ; and a part of the external rectus placed below the lacrimal nerve. The frontal nerve is to be followed backwards till its entrance through the superior orbital fissure is noted; it should then be traced forwards up to its division into the supraorbital branch (which is accompanied by an artery of the same name) and the supratrochlear branch. Both the branches are to be traced to the points of their exit from the orbit. Similarly trace the lacrimal nerve and lacrimal artery backwards and then forwards to their destination to the lacrimal gland. Follow the trochlear nerve from the point of its entrance to its termination on the superficial surface of the superior oblique muscle.

The **Lacrimal Gland** has been described (p. 279). Its two portions, superior and inferior, which are separated from each other by the expanded tendon of the levator palpebræ superioris can now be fully examined.

The **Frontal Nerve** is the largest of the three branches of the ophthalmic nerve. Entering the orbit through the superior orbital fissure, it runs forwards between the levator palpebræ superioris and the periosteum and terminates about the middle of the orbit by dividing into two branches, the supratrochlear and the supraorbital. The *supratrochlear nerve* passes forwards and medialwards above the pulley of the superior oblique muscle and piercing the orbital septum emerges from the orbit at its upper and medial angle (p. 200). The *supraorbital nerve* passes forwards and leaves the orbit through the supraorbital notch (p. 200).

The **Lacrimal Nerve** is the smallest of the three branches of the ophthalmic nerve. Entering the orbit through the superior orbital fissure, it runs along the upper margin of the lateral rectus muscle in company with the lacrimal artery. It is then continued forwards beneath the lacrimal gland to which it supplies filaments; it pierces the orbital septum and terminates in the skin of the upper eyelid. Near the lacrimal gland it gives a twig which passes downwards to communicate with the zygomatic branch of the maxillary nerve.

The **Trochlear Nerve** enters the orbit through the superior orbital fissure and passing medialwards above the origin of the levator palpebræ superioris, ends in the back part of the superior oblique muscle on its superficial surface.

Dissection. Divide the frontal nerve and reflect its ends forwards and backwards. Clean the levator palpebræ and on

lifting it gently a filament from the oculomotor nerve will be seen to enter it after piercing the superior rectus. Clean the superior oblique and note that it ends in a tendon which passes through a pulley and that it is supplied by the trochlear nerve.

The **Levator Palpebræ Superioris** arises from the under surface of the roof of the orbit just above and in front of the optic foramen. It is pointed at its origin and widens in front into an expansion, the insertion of which has been described (p. 278). It is supplied by the superior division of the oculomotor nerve which enters its deep surface. It raises the upper eyelid.

The **Superior Oblique** arises from the upper and medial margin of the optic foramen above and medial to the origin of the rectus superior. It passes forwards towards the upper and medial angle of the orbit and ends in a tendon which passes through a fibrocartilaginous ring, called the *trochlea* or *pulley*, attached to the trochlear fossa of the frontal bone. It then suddenly changes its direction downwards, backwards and lateralwards under cover of the superior rectus and becomes inserted into the sclera between the rectus superior and rectus lateralis. It is supplied by the trochlear nerve. It turns the cornea downwards and lateralwards. The trochlea is lined by a mucous sheath which facilitates the movement of the tendon inside it.

Dissection. Divide the levator palpebræ superioris and reflect its ends forwards and backwards. The superior rectus muscle is now seen.

The **Rectus Superior** arises from that part of the fibrous ring which is attached to the upper margin of the optic foramen, and is inserted into the sclera at its upper and anterior part about one fourth of an inch behind the sclero-corneal junction. It is supplied by a branch from the superior division of the oculomotor nerve which enters its deep surface. It turns the cornea upwards.

Dissection. Divide the superior rectus about its middle and reflect the cut ends forwards and backwards. While turning the posterior part of the muscle backwards, the superior division of the oculomotor nerve will be found to enter into its deep surface. On removing a quantity of fat the optic nerve is seen. The nasociliary nerve, the ophthalmic artery and the superior ophthalmic vein are to be followed as they cross the optic nerve and their branches are to be traced carefully by removing the fat between the optic nerve and rectus lateralis. At the back part of the orbit and on the lateral side of the optic nerve look for the

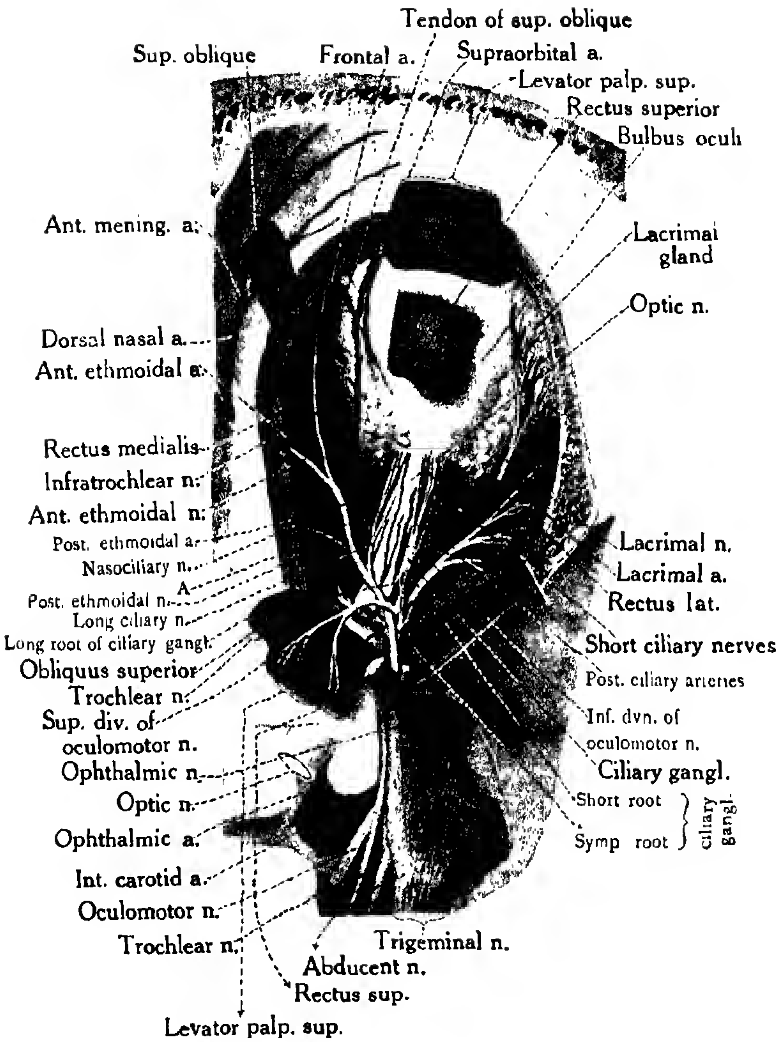


Fig. 101.—Dissection of the orbit (Sobotta)

To face P. 336

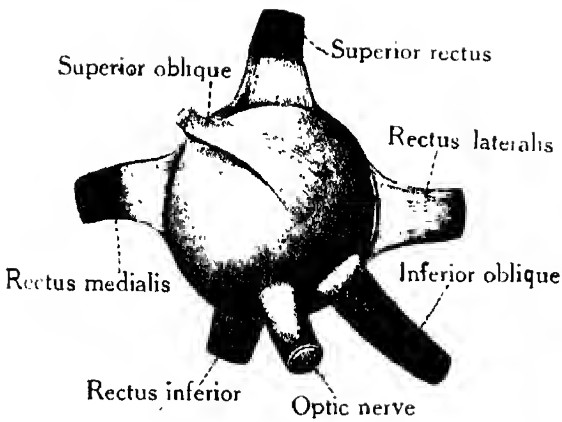


Fig 102 —Diagram of the ocular muscles.

small ciliary ganglion. This ganglion will be reached if its long root derived from the nasociliary nerve or its short root derived from the branch of the inferior division of the oculomotor nerve supplying the inferior oblique muscle is traced. Lastly, clean the optic nerve fully and separate from one another, the two divisions of the oculomotor nerve, the naso-ciliary nerve and the abducent nerve which pass between the two heads of the rectus lateralis.

The **Nasociliary Nerve** (Nasal nerve) enters the orbit between the two heads of the rectus lateralis. Crossing the optic nerve it passes medialwards between the rectus medialis and superior oblique muscles and enters the anterior ethmoidal foramen under the name of the *anterior ethmoidal nerve.* Passing through this foramen it enters the cranial cavity and passes forwards along the lateral edge of the lamina cribrosa of the ethmoidal bone under cover of the dura mater. It then enters the nasal cavity through a slit by the side of the crista galli and runs downwards along the inner surface of the nasal bone. Here it gives off *internal nasal branches* to the mucous membrane of the nose. Finally it leaves the nasal fossa and appears on the face as the *external nasal nerve* between the lower border of the nasal bone and the lateral cartilage of the nose (p. 275). The following branches are given off from the nasociliary nerve :—(1) The *long root of the ciliary ganglion* arises as the nerve proceeds between the two heads of the rectus lateralis ; it then passes along the lateral side of the optic nerve to join the postero-superior angle of the ciliary ganglion. Sometimes the sympathetic root from the cavernous plexus joins the long root. (2) The *long ciliary nerves,* two or three in number, arise from the nasociliary as it crosses the optic nerve and proceed forwards to the eyeball where they pierce the back part of the sclera to supply the ciliary body, iris and cornea. (3) The *posterior ethmodial nerve* passes through the posterior ethmoidal foramen to supply the ethmoidal cells and the sphenoidal sinus. (4) The *infratrochlear nerve* arises from the nasociliary just before it enters the anterior ethmoidal foramen and passes beneath the superior oblique muscle and its trochlea. It then leaves the orbit and appears on the face (p. 275). Near the pulley it is joined by a filament from the supratrochlear nerve.

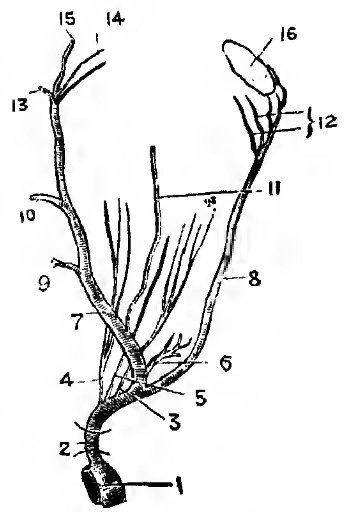
The **Ciliary Ganglion** (Lenticular ganglion) is a minute reddish body of the size of a pin's head, situated at the back part of the orbit between the rectus lateralis and the optic nerve.

It is quadrangular in shape. Like other cranial ganglia it has three roots which enter its posterior border. The short or *parasympathetic root* is thick and is derived from the branch of the inferior division of the oculomotor nerve which goes to supply the inferior oblique muscle; it joins the postero-inferior angle of the ganglion. The long or *sensory root* is slender and joins the postero-superior angle of the ganglion; it is derived from the nasociliary nerve. The *sympathetic root* is derived from the cavernous plexus of the sympathetic and joins the ganglion below the sensory root; sometimes it joins the sensory root itself. The *branches* of the lenticular ganglion are the *short ciliary nerves* which arise from the anterior border of the ganglion. They are six to ten in number and are arranged int two groups; an upper group, running above the optic nerve and a lower group, below that nerve. They proceed forwards accompanied by the ciliary arteries and long ciliary nerves and pierce the sclera around the optic nerve to supply the iris, cornea and the ciliary muscle.

The **Optic Nerve** enters the orbit through the optic foramen and lies above and medial to the ophthalmic artery. It passes through the orbit surrounded by the recti muscles and accompanied by the ciliary vessels and nerves. The ophthalmic artery lies below and lateral to it. It pierces the back part of the sclera a little to the medial side of its centre and expands into the retina inside the eyeball.

The **Ophthalmic Artery** arises from the internal carotid artery on the medial side of the anterior clinoid process and enters the orbit through the optic foramen in company with the optic nerve lying immediately below and lateral to it. The vessel then crosses the optic nerve obliquely from its lateral to the medial side, runs forwards along the medial wall of the orbit beneath the lower border of the superior oblique muscle and divides into two terminal branches, the frontal and dorsal nasal arteries. *Branches.*—(1) The *lacrimal artery* arises near the optic foramen and passes forwards in company with the lacrimal nerve to the lacrimal gland which it supplies as well as the conjunctiva. It gives off (a) two *lateral palpebral branches* which run medialwards, one in each eyelid, near its free margin and form an arterial arch, *arcus tarseus*, by anastomosing with the medial palpebral branches of the ophthalmic artery of the opposite side; (b) *muscular branches* to the neighbouring muscles; (c) one or two *zygomatic branches* which emerge from the orbit through a foramen in its lateral wall; (d) a *recurrent meningeal*

branch which enters the cranial cavity through the lateral part of the superior orbital fissure to supply the dura mater. (2) The *arteria centralis retinæ* is a very small branch which pierces the under surface of the optic nerve about half an inch behind the eyeball and proceeds forwards in the substance of the nerve to the retina. (3) The *muscular branches* supply the muscles of the orbit. Some of them arise from the parent trunk while others are derived from its lacrimal and supraorbital branches. These muscular branches give off the *anterior ciliary arteries* which form an arterial anastomosis beneath the conjunctiva and then pierce the sclera behind the sclerocorneal junction. (4) The *posterior ciliary arteries* arise by two trunks which subdivide into numerous branches. These branches pierce the sclera around the entrance of the optic nerve to supply the chorioid and ciliary processes. Two of these branches are longer than the others and are called the *long posterior ciliary arteries*.(5) The *supraorbital artery* accompanies the nerve of the same name between the periosteum and the levator palpebræ superioris and reaches the forehead through the supraorbital notch or foramen (p. 199). In the orbit it gives off muscular branches to the neighbouring muscles. (6) The *anterior ethmoidal artery* accompanies the anterior ethmoidal nerve and passes through the anterior ethmoidal canal and supplies the anterior and middle



1. Internal carotid artery.
2. Ophthalmic artery.
3. 4. Posterior ciliary arteries.
5. Arteria centralis retinæ.
6. Muscular branches.
7. Ophthalmic artery.
8. Lacrimal artery.
9. Posterior ethmoidal artery.
10. Anterior ethmoidal artery.
11. Supraorbital artery.
12. Lateral palpebral arteries.
13. Dorsal nasal artery.
14. Medial palpebral arteries.
15. Froutal artery.
16. Lacrimal gland.

Fig. 103.—Diagram of the ophthalmic artery and its branches (Buchanan).

ethmoidal cells and the frontal sinus. Inside the cranium it gives off an *anterior meningeal branch* (p. 216) which supplies the dura mater. Entering the nasal cavity it gives off nasal branches to supply the mucous membrane of the nose and ultimately appears on the side of the nose between the lower border of the nasal bone and the lateral nasal cartilage. (7) The *posterior ethmoidal artery* passes through the posterior ethmoidal canal and supplies the posterior ethmoidal cells. Entering the cranium it gives off a meningeal branch to the dura mater and nasal branches which, passing through the apertures in the lamina cribrosa of the ethmoidal bone, supply the upper part of the nasal cavity. (8) The *medial palpebral arteries* are two in number, a superior and an inferior. They arise close to the pulley of the superior oblique and run lateralwards, one in each eyelid near its free margin, to anastomose with the lateral palpebral branches already described. (9) The *frontal artery* is one of the terminal branches and accompanies the supratrochlear nerve (p. 198). (10) The *dorsal nasal artery* is the other terminal branch. It leaves the orbit at its medial angle, supplies the outer surface of the root of the nose and anastomoses with the angular artery.

The **Ophthalmic Veins** are two in number, superior and inferior. The *superior ophthalmic vein* begins at the medial angle of the orbit as the nasofrontal vein which communicates with the angular vein. It accompanies the ophthalmic artery and receives tributries corresponding to the branches of the artery ; it passes backwards between the two heads of the rectus lateralis and opens into the cavernous sinus. The *inferior ophthalmic vein* is formed at the front part of the floor of the orbit by some minute veins. It runs backwards below the eyeball and the optic nerve, receives some tributaries, and divides into two branches. One of these communicates with the pterygoid venous plexus through the inferior orbital fissure and the other ends in the cavernous sinus either directly or in common with the superior ophthalmic vein.

Recti and the Common Tendinous Ring.—A fibrous or tendinous ring surrounds the optic foramen which is the common origin of the four recti muscles. This ring is attached to the upper, medial and lower margins of the optic foramen. From the lower margin it passes lateralwards bridging over the medial end of the superior orbital fissure and becomes attached to the tubercle on the margin of the great wing of the sphenoidal bone forming the lower boundary of the fissure. From this tubercle the band

passes to the lateral and upper parts of the optic foramen, thus completing the ring. The upper part of the ring is called the *tendon of Lockwood* and the lower part, the *tendon of Zinn.* The *rectus superior* has been examined. The *rectus medialis* arises from the part of the fibrous ring on the medial margin of the optic foramen. The *rectus inferior* arises from the part of the fibrous ring which extends along the lower margin of the optic foramen. The *rectus lateralis* arises by two heads, a superior and an inferior. The superior head arises from the lateral part of the fibrous ring above the optic foramen. The inferior head arises from the lateral part of the fibrous ring below the optic foramen and the tubercle on the great wing of the sphenoidal bone which bounds the superior orbital fissure below. Between these two heads the superior and inferior divisions of the oculomotor nerve, the nasociliary nerve, the abducent nerve and the ophthalmic veins pass. Each rectus muscle is directed forwards and is inserted by a membranous tendon into the selera on the part indicated by its name about one-fourth of an inch behind the sclero-corneal junction. The medial and inferior recti are supplied by the inferior division of the oculomotor nerve; the rectus lateralis by the abducent nerve. The rectus medialis turns the cornea medialwards; the rectus inferior, downwards; the rectus lateralis, lateralwards.

The **Abducent Nerve** passes between the two heads of the rectus lateralis and enters the ocular surface of the muscle to supply it.

The **Oculomotor Nerve** breaks up into a superior and inferior division before entering the superior orbital fissure; the two divisions then enter the orbit through this fissure between the two heads of the rectus lateralis. The *superior division* has been seen to pass above the optic nerve and supply the levator palpebræ superioris and superior rectus muscles. The *inferior division* breaks up into three branches for the supply of the rectus medialis, the rectus inferior and the obliquus inferior. The nerve to the last named muscle is long and gives off the short or parasympathetic root to the ciliary ganglion. It passes forwards between the rectus inferior and the rectus lateralis to enter the posterior border of the inferior oblique muscle.

Dissection. To expose the inferior oblique muscle, replace the eyeball in its natural position. Divide the conjunctiva at the inferior fornix; dissect out the muscle at the anterior part of the floor of the orbit; on removing some fat it will be seen to proceed laterally to be inserted into the lateral aspect of the sclera.

The **Inferior Oblique Muscle** arises from a depression on the orbital surface of the maxilla just lateral to the aperture for the nasolacrimal duct. It passes lateralwards, backwards and upwards at first between the inferior rectus and the floor of the orbit, and then between the eyeball and rectus lateralis to be inserted into the lateral aspect of the sclera between the lateral and superior recti. It is supplied by the inferior division of the oculomotor nerve. It turns the cornea upwards and lateralwards.

The **Fascia Bulbi** (capsule of Tenon) is a membrane which covers the sclera from the optic nerve behind to the sclerocorneal junction in front. Its inner surface is smooth and is separated from the sclera by perisceral lymph space containing loose areolar tissue. Its external surface is covered by the fatty tissue of the orbit. Posteriorly it is pierced by the ciliary vessels and nerves and by the optic nerve with the sheath of which it is continuous. Anteriorly it is blended with the ocular conjunctiva near the margin of the cornea. It is perforated by the tendons of the ocular muscles which are inserted into the sclera and is prolonged backwards on them as tubular sheaths to be continuous with the perimysium of the muscles. The sheath on the superior oblique muscle extends up to its pulley; that on the inferior oblique up to the floor of the orbit. The sheath on the rectus medialis sends a triangular process medialwards to be attached to the lacrimal bone. This is called the *medial check ligament*. Similarly the sheath on the rectus lateralis sends a triangular process to be attached to the zygomatic bone. This is called the *lateral check ligament*. These check ligaments are so called because they check or limit the actions of the two recti. The sheath on the inferior rectus is strengthened and is blended on either side with the check ligaments forming the *suspensory ligament* (Lockwood) which stretches across the anterior part of the orbit below the eyeball like a hammock and is attached medially to the lacrimal bone and laterally to the zygomatic bone. The sheath prolonged on the superior rectus blends superiorly with the tendon of the levator palpebræ.

Dissection. Divide the conjunctiva by a circular incison behind the cornea and reflect it backwards together with the fascia bulbi up to the point of entrance of the tendons of the ocular muscles. Note the apertures for the tendons and the tubular sheaths prolonged backwards from the margins of the openings on the muscles.

MOUTH, PHARYNX AND PALATE

The dissector should now take the anterior part of the divided skull and proceed to study in the order given below.

The **Mouth** consists of an outer portion called the vestibule and an inner portion called the cavity proper of the mouth. The *vestibule* of the mouth is a slit-like space bounded in front by the lips and cheeks and behind by the gums and teeth. In front it presents the *orifice of the mouth*; and the parotid ducts open into it posteriorly. It communicates with the cavity of the mouth proper behind the last molar teeth. The *cavity proper* of the mouth is bounded in front and laterally by the teeth and gums covering the aveolar arches. Behind it leads to the pharynx through the isthmus of the fauces. Its *floor* is formed by the tongue and the mucous membrane extending from the organ to the inner aspect of the mandible. Its *roof* is formed by the hard and soft palates. The ducts of the submaxillary and sublingual glands open into it.

The **Lips** (Labia oris) are lined externally by skin and internally by mucous membrane and enclosed between them are the orbicularis oris with other facial muscles converging into it, the labial glands and vessels. The fold of the mucous membrane in the middle line connecting the inner aspect of each lip with the gum covering the corresponding alveolar arch is called the *frenulum*. The upper and the lower lip form by their junction, on either side, the *labial commissure* which bounds the *angle of the mouth*. The vertical groove descending from the columna nasi on the middle of the outer surface of the upper lip is called the *philtrum*.

The **Cheeks** (buccæ) are lined externally by skin and internally by the mucous membrane of the mouth and between them are enclosed muscles (chiefly the buccinator), a large quantity of fat and areolar tissue, branches of the external maxillary artery and facial nerve, and buccal glands.

The **Gums** cover the alveolar processes and surround the necks of the teeth. They are composed of dense fibrous tissue covered by mucous membrane.

The **Teeth** are thirty-two in number, sixteen in each jaw, viz., four incisors, two canines, four premolars or bicuspids and six molars. Each tooth consists of (1) the crown or the portion projecting above the level of the gum; (2) the neck or the part

surrounded by the gum ; and (3) the root or the portion embedded within the alveolus.

The **Isthmus of the Fauces** is the opening by which the cavity of the mouth communicates with the pharynx. It is bounded above by the soft palate, below by the dorsum of the tongue and on either side by an arched fold called the glossopalatine arch. The *glossopalatine arch* (anterior pillar of the fauces) is formed by the glossopalatinus covered by mucous membrane and extends from the soft palate downwards, lateralwards and forwards, to the side of the tongue.

Directions. The pharynx should be filled with tow and the part fixed with hooks on a block.

The **Pharynx** is a musculo-membranous tube, about five inches in length, extending from the base of the skull to the body of the sixth cervical vertebra. It serves as the passage for carrying air to the larynx and food to the œsophagus. Its greatest breadth is at the base of the skull ; then it narrows opposite the hyoid bone ; its narrowest portion is opposite the cricoid cartilage where it becomes continuous with the œsophagus. *Above*, it is attached to the base of the skull ; *behind*, it is connected by loose areolar tissue with the prevertebral fascia. *In front*, the pharynx is deficient where it communicates with the nasal cavities, the mouth and the larynx ; and is limited by its attachment on either side from above downwards to the medial pterygoid lamina, the pterygomandibular raphe, the mandible, the tongue, the hyoid bone and the thyreoid and cricoid cartilages. *Laterally*, it is in relation with the styloid process and the muscles attached to it, and the great vessels and nerves of the neck. *Below*, it opens into the œsophagus.

Structure of the pharynx.—The wall of the pharynx is composed of the following layers from without inwards : (1) buccopharyngeal fascia, (2) pharyngeal venous plexus, (3) muscular layer, (4) fibrous layer or pharyngeal aponeurosis, and (5) mucous membrane.

The *buccopharyngeal fascia* covers the pharynx and the buccinator and has been described (p. 328). The ***pharyngeal venous plexus*** is formed by a number of small veins ramifying and joining with each other upon the muscular wall of pharynx. This plexus terminates in two or more pharyngeal veins which open into the internal jugular vein. The ***muscular layer*** is composed of the three constrictor muscles and the stylopharyngeus, pharyngopalatinus and salpingopharyngeus muscles.

Dissection. Clean the surfaces of the constrictor muscles by removing the remains of the buccopharyngeal fascia and the pharyngeal plexuses of veins and nerves.

The **Constrictor Muscles** of the pharynx are three in number, superior, middle and inferior.

The *inferior constrictor muscle* arises (1) from the side of the cricoid cartilage, (2) from the inferior cornu and oblique line of the thyreoid cartilage, and (3) from the surface of the thyreoid cartilage behind the oblique line. The fibres from these origins pass in an arched manner backwards and medialwards and become inserted, with the muscle of the opposite side, into the postero-median raphe of the pharynx. The lower fibres are horizontal and continuous with the circular fibres of the œsophagus. The upper fibres are oblique and overlap the lower

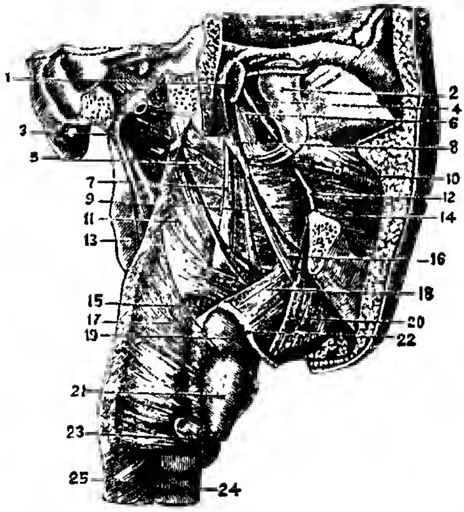


Fig. 104.—Side view of the pharynx (from Sappey).

1. Auditory tube.
2. Lateral pterygoid lamina.
3. Left styloid process.
4. Tensor veli palatini.
5. Superior constrictor.
6. Levator veli palatini.
7. Stylopharyngeus, upper part.
8. Right styloid process.
9. Stylohyoid muscle.
10. Parotid duct.
11. Middle constrictor.
12. Pterygomandibular raphe.
13. Internal pterygoid muscle.
14. Buccinator muscle.
15. Stylopharyngeus, lower part.
16. Styloglossus.
17. Inferior constrictor.
18. Hyoglossus.
19. Hyothyreoid membrane.
20. Mylohyoid muscle.
21. Thyreoid cartilage.
22. Hyoid bone.
23. Cricothyreoid muscle.
24. Trachea.
25. Œsophagus.

part of the middle constrictor The internal laryngeal nerve lies near the upper border and the recurrent nerve near the lower border of the muscle prior to their entrance into the larynx.

The *middle constrictor muscle* is triangular in shape and arises by its narrow end (1) from the upper border of the greater cornu of the hyoid bone, (2) from the lesser cornu, and (3) from the lower end of the stylohyoid ligament. The fibres diverge backwards and medialwards in a fan-shaped manner and become inserted, with the muscle of the opposite side, into the posteromedian raphe. The lower fibres are overlapped by the inferior constrictor and the upper fibres overlap the superior constrictor muscle.

The *superior constrictor muscle* is quadrilateral in shape and arises (1) from the lower third of the posterior border of the medial pterygoid lamina and its hamulus, (2) from the pterygomandibular raphe, (3) from the posterior end of the mylohyoid line of the mandible, and (4) from the side of the tongue. The fibres arch backwards and medialwards and are inserted into the posteromedian raphe—the highest fibres being inserted into the pharyngeal spine on the basilar portion of the occipital bone. The upper border of the muscle is concave and does not reach the base of the skull; the gap (*sinus of Morgagni*) is filled up by the pharyngobasilar fascia and transmits the levator veli palatini and the auditory tube. The lower border of the muscle is overlapped by the midde constrictor; and between the two muscles in this situation, the stylopharyngeus proceeds to its insertion.

Nerve-supply.—The constrictor muscles are supplied by the pharyngeal plexus of nerves, the inferior constrictor receiving additional branches from the external laryngeal and recurrent nerves. *Actions.*—They diminish the size of the pharynx and in swallowing the bolus of food is forced into the œsophagus by the successive actions of the superior, middle and inferior constrictors.

The pharyngopalatinus and the salpingopharyngeus will be studied later on.

The **Pharyngeal Aponeurosis** forms the fibrous layer of the wall of the pharynx lying between the muscular layer and the mucous membrane. At the upper part of the pharynx between the concave upper margin of the superior constrictor and the base of the skull where the muscle fibres are absent it is thick and strong and is called the *pharyngobasilar fascia*,

which is attached above to the basilar portion of the occipital bone and the petrous portion of the temporal bone. As it descends it gradually diminishes in thickness and is ultimatey lost between the muscular and mucous layers. It is strengthened posteriorly by a tendinous band, the *postero-median raphe of the pharynx*, which is attached above to the pharyngeal spine of the basilar part of the occipital bone and then descends vertically.

Dissection. Lay open the pharynx by a vertical incision in the middle line along its posterior wall and then divide it transversely near its attachment to the base of the skull. Then remove the tow and clean its interior.

The student should note that the pharynx may be subdivided from above downwards into three portions : (1) the nasal portion lying above the level of the soft palate ; (2) the oral portion lying below the level of the soft palate, between it and the hyoid bone ; and (3) the laryngeal portion from the level of the hyoid bone to that of the cricoid cartilage. The mucous membrane lining these three portions should also be studied.

The **Nasal Portion** (nasopharynx) is the uppermost part of the pharynx and communicates in front with the nasal cavities by the choanæ. On the lateral wall at the lower and back part of the choanæ is seen on either side the *ostium pharyngeum* or pharyngeal opening of the auditory tube. This opening is bounded behind by an elevation called the *torus tubarius* (Eustachian cushion). From the lower part of the torus an elevated fold of mucous membrane, called the *salpingopharyngeal fold*, descends vertically along the lateral wall of the pharynx. This prominence is caused by salpingopharyngeus muscle covered by mucous membrane. Behind the torus is a depression called the *pharyngeal recess* (fossa of Rosenmuller). The mucous membrane of the posterior wall presents a collection of lymphoid tissue called the *pharyngeal tonsil* which is best seen in childhood. The *roof* is formed by the basilar portion of the occipital bone and the basisphenoid covered by mucous membrane, and the *floor*, by the upper surface of the soft palate.

The **Oral Portion** communicates in front with the cavity of the mouth through the isthmus of the fauces. On its lateral wall behind the glossopalatine arch is seen on either side another arched fold called the *pharyngopalatine arch* (posterior pillar of the fauces) ; this arch extends from the soft palate downwards, lateralwards and backwards to the lateral wall of the pharynx

and is caused by the pharyngopalatinus muscle covered by mucous membrane. Between the glossopalatine arch in front and the

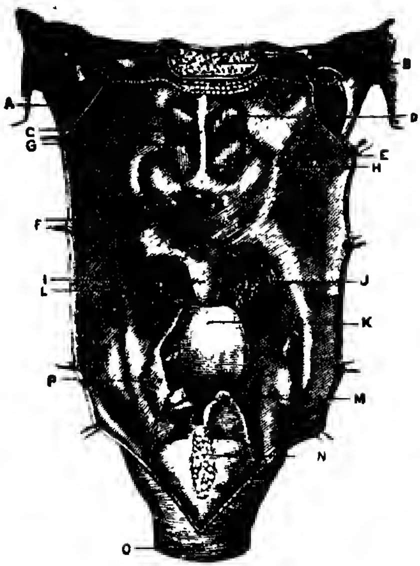


Fig. 105.—Pharynx laid open from behind (Sappey).

A. Styloid process.
B. Occipital bone.
C. Septum nasi.
D. Middle nasal concha.
E. Inferior nasal concha.
F. Soft palate.
G. Choana.
H. Auditory tube.
I. Uvula.
J. Palatine tonsil.
K. Epiglottis.
L. Back of tongue.
M. Tip of arytænoid cartilage.
N. Back of cricoid cartilage.
O. Œsophagus.
P. Aryepiglottic fold.

pharyngopalatine arch behind is a triangular depression at the lower part called the *sinus tonsillaris* which lodges the palatine tonsil. The upper part of the sinus tonsillaris above the level of the palatine tonsil is called the *supratonsillar fossa.*

The **Laryngeal Portion** of the pharynx presents in its anterior wall the superior aperture of the larynx. This aperture is triangular in shape and its base is formed by the upper border of the epiglottis and the sides by two folds of mucous membrane, called the aryepiglottic folds, which extend from the lateral margins of the epiglottis to the arytænoid cartilages. On each side of the laryngeal opening is a recess called the *sinus piriformis* which is bounded laterally by the thyreoid cartilage and the hyothyreoid membrane and medially by the arytænoid cartilage and the aryepiglottic fold.

The **Soft Palate** is a musculomembranous partition which intervenes between the cavity of the mouth and the nasal part of the pharynx. It is a movable partition which can close the opening from the pharynx into the mouth (when it is depressed) or shut off communication with the nasal cavities (when it is elevated). It consists of a fold of mucous membrane, between the two layers of which are enclosed (1) a number of muscles, (2) an aponeurosis—the palatine aponeurosis, (3) vessels, (4) nerves, and (5) mucous glands. Its anterior margin is attached to the posterior border of the hard palate. Its posterior margin is free and from the centre of it hangs a conical projection called the *uvula ;* from the base of the uvula on either side two arched folds, the *pillars of the fauces,* curve downwards. Laterally it is blended with the sides of the pharynx. Its upper surface is convex and is continuous with the floor of the nasal cavities ; its under surface is concave and is continuous with the roof of the mouth.

Dissection. To dissect the muscles the soft palate should be made tense by means of hooks and the mucous membrane from its upper and lower surfaces and from the pillars of the fauces is to be removed. The muscles are the musculus uvulæ, the levator veli palatini, the tensor veli palatini, the glossopalatinus and the pharyngopalatinus. The levator veli palatini will be exposed fully by removing the mucous membrane between the opening of the auditory tube above and the upper margin of the superior constrictor of the pharynx below.

The **Musculus Uvulæ** (Azygos uvulæ) arises from the posterior nasal spine of the palatine bone and is inserted after uniting with its fellow of the opposite side into the submucous tissue of the uvula. It is supplied by the accessory nerve through the pharyngeal plexus. It elevates the uvula.

The **Levator Veli Palatini** (Levator palati) arises (1) from the rough area on the under surface of the petrous bone and (2) from the medial lamina of the cartilage of the auditory tube. It passes downwards and forwards, pierces the pharyngobasilar fascia close to the upper border of the superior constrictor muscle and is inserted into the soft palate and into the palatine aponeurosis. The posterior fibres of the muscle are continuous with the corresponding fibres of the opposite side across the middle line. It is supplied by the accessory nerve through the pharyngeal plexus. It elevates the soft palate.

The **Tensor Veli Palatini** (Tensor palati) arises (1) from the

scaphoid fossa at the base of the medial pterygoid lamina, (2) from the medial aspect of the spina angularis, and (3) from the lateral lamina of the cartilage of the auditory tube. It passes vertically downwards along the lateral surface of the medial pterygoid lamina and ends in a tendon which passes horizontally medialwards hooking round the pterygoid hamulus. The tendon then expands and is inserted into (1) the palatine aponeurosis and (2) into the transverse ridge and the surface of bone behind it on the under surface of the horizontal part of the palatine bone. It is supplied by the mandibular nerve through the otic ganglion. It makes the soft palate tense.

The **Glossopalatinus** (Palatoglossus) arises from the anterior surface of the soft palate where its fibres are continuous with those of the opposite side across the middle line. It passes downwards, lateralwards and forwards to be inserted into the posterior part of the side of the tongue. It is supplied by the accessory nerve through the pharyngeal plexus. When the two muscles act they approximate the anterior pillars and thus shut off the cavity of the mouth from the pharynx.

The **Pharyngopalatinus** (Palatopharyngeus) at its origin from the soft palate consists of two strata, an upper and a lower The *upper stratum* is the uppermost muscular layer in the soft palate lying just beneath the mucous membrane and is continuous across the middle line with the corresponding stratum of the opposite side. The *lower stratum* arises from the posterior border of the palatine bone, and from the palatine aponeurosis; some of the fibres are continuous, with those of the opposite side along the middle line. Between these two strata are enclosed the musculus uvulæ and the levator veli palatini. At the lateral border of the soft palate these two strata unite and are reinforced by another muscular slip, the *salpingo-pharyngeus muscle,* which arises from the lower border of the cartilage of the auditory tube. The muscle with the three parts blended then passes downwards and backwards forming with the overlying mucous membrane, the pharyngopalatine fold. It next blends with the stylopharyngeus and becomes inserted into the posterior border of the thyreoid cartilage and into the lateral wall of the pharynx. It is supplied by the accessory nerve through the pharyngeal plexus. It raises the larynx and lower part of the pharynx.

The **Palatine Aponeurosis** is a strong fibrous membrane which supports the muscles of the soft palate. In front it is attached to the posterior border of the hard palate where it is

thick. It becomes very thin behind and cannot be demonstrated near the free margin of the soft palate.

Vessels of the Soft Palate.—These are three in number; (1) the ascending palatine branch of the external maxillary artery (p. 296), (2) the palatine branch of the ascending pharyngeal artery (p. 319), and (3) the descending palatine branch of the internal maxillary artery, which is described later.

Nerves of the Soft Palate.—The nerves supplying the muscles of the soft palate have been already noted. The posterior and middle palatine nerves descend from the sphenopalatine ganglion and supply the mucous membrane of the soft palate.

The *palatine glands* are seen on its posterior surface and round the uvula.

The **Auditory Tube** (Eustachian Tube) establishes communication between the tympanic cavity and the nasal part of the pharynx. It is about one and a half inches (36 mm.) in length. The lateral third of the tube is bony, whereas the medial two-thirds is formed partly by cartilage and partly by fibrous tissue. On removing the mucous membrane of the pharynx the cartilaginous and fibrous portion of the tube will be exposed. The tube passes backwards, lateralwards and slightly upwards from the pharynx. The cartilaginous portion is formed by the folding of a triangular lamina of fibrocartilage in such a way that the medial and upper walls are formed by it, leaving a gap in the lateral and lower walls which is filled up by fibrous tissue. A muscular slip, called the *dilator tubæ*, arises from the lateral margin of the cartilage and descends to join the tensor veli palatini. The lumen of the tube is widest at the pharyngeal opening and narrowest at the junction of the cartilaginous and bony portions. This narrowest part is called the *isthmus*.

The **Palatine Tonsils** are two rounded bodies of lymphoid tissue placed in the lower parts of the sinus tonsillaris, one on each side. The *lateral* or *deep surface* of each tonsil is covered by an incomplete fibrous capsule and is embedded in some loose connective tissue which lies against the superior constrictor of the pharynx. Its *free* or *medial surface* presents many minute orifices leading into crypts or recesses. A semilunar fold of the mucous membrane extends backwards from the glossopalatine arch forming the medial wall of the supratonsillar fossa. This fold is called the *plica semilunaris*. The student should note that the tonsil lies in relation (1) with the external maxillary artery,—the pharyngeal wall intervenes between it and this

artery ; (2) with the internal and external carotid arteries which lie about an inch behind and lateral to it. The arteries supplying the tonsil are the dorsalis linguæ branch of the lingual, the ascending palatine and tonsillar branches of the external maxillary, the ascending pharyngeal artery and the descending palatine branch of the internal maxillary artery.

THE CAROTID CANAL

Dissection. To expose the carotid canal in the petrous portion of the temporal bone remove its inferior wall with the bone forceps, taking the internal carotid artery as a guide.

The **Internal Carotid Plexus** is placed on the lateral side of the internal carotid artery in the carotid canal. The dissector has traced the internal carotid nerve derived from the superior cervical ganglion of the sympathetic trunk accompanying the internal carotid artery up to the inferior opening of the carotid canal. In the canal the internal carotid nerve divides into two branches, a medial and a lateral. The lateral branch breaks up into filaments to form the *internal carotid plexus* on the lateral side of the artery. The medial branch gives off filaments to the internal carotid plexus and enters the wall of the cavernous sinus to form the *cavernous plexus*. Occasionally a minute ganglion, *carotid ganglion*, is seen in the internal carotid plexus. *Branches of the internal carotid plexus*.—The plexus communicates with (1) the tympanic plexus by the *superior* and *inferior caroticotympanic branches* which join the tympanic plexus traversing the wall of the carotid canal, (2) with the sphenopalatine ganglion by means of a branch, the *deep petrosal nerve*, which pierces the cartilage filling up the foramen lacerum and joins the greater superficial petrosal nerve forming the *nerve of the pterygoid canal* (Vidian nerve), (3) with the semilunar ganglion, and (4) with the abducent nerve.

Internal Carotid Artery.—Its petrous portion is now seen. On entering the carotid canal it first ascends vertically and then turns forwards and medialwards. It leaves the canal, enters the cranial cavity at the apex of the petrous bone and, passing across the foramen lacerum, ascends to enter the wall of the cavernous sinus. The tympanic cavity and the cochlea lie behind it, and the semilunar ganglion lies above it near its exit from the canal. A minute branch of the artery, called the *caroticotympanic branch*, enters the tympanic cavity through

a minute foramen in the posterior wall of the canal; another small twig, the *pterygoid branch*, passes into the pterygoid canal.

The *carotid plexus of veins* accompanies the internal carotid artery in the carotid canal.

THE OTIC GANGLION

Dissection. Reference has been made of the otic ganglion during the dissection of the infratemporal region. This ganglion should now be searched for in the infratemporal region. Look for the middle meningeal artery where it is embraced by the roots of the auriculotemporal nerve. The ganglion lies in front of the middle meningeal artery, close to the foramen ovale, and medial to the mandibular nerve. If the nerve to the internal pterygoid muscle is secured it will lead to the otic ganglion, for two or three filaments from this nerve join the otic ganglion and form its motor root.

The **Otic Ganglion** is a small oval ganglion placed immediately below the foramen ovale, on the medial side of the mandibular nerve, and in front of the middle meningeal artery. Its *motor root* is formed by two or three filaments derived from the nerve to the pterygoideus internus; the *sensory root* is derived from the lesser superficial petrosal nerve which joins the ganglion at its posterior border; the *parasympathetic root* is supplied by the facial nerve through the lesser superficial petrosal nerve. The *sympathetic root* comes from the plexus around the middle meningeal artery. The *branches* of the otic ganglion are :—(1) branch to the tensor veli palatini which passes forwards and enters the muscle, (2) a twig which passes backwards and supplies the tensor tympani, and (3) communicating filaments to the chorda tympani nerve and filaments to one or both roots of the auriculo-temporal nerve.

THE MAXILLARY NERVE

Dissection. Remove the temporal muscle as also the origin of the pterygoideus externus. Saw through the skull; begin at the cut margin above the external acoustic meatus and proceed downwards and forwards towards the medial end of the superior orbital fissure along the lateral side of the foramen rotundum—this saw-cut will pass through the squamous part of the temporal bone and the great wing of the sphenoidal bone. Another saw-cut is to be made from the sawn margin of the skull above the

anterior border of the great wing of the sphenoidal bone in a downward direction to the termination of the first saw-cut. Remove the piece of bone included between these two cuts. For convenience of dissection, remove the remainder of the great wing of the sphenoidal bone but keep the circumference of the foramen rotundum intact. Remove the periosteum from the floor of the orbit. Finally, lay open the whole length of the infraorbital canal. The maxillary nerve and its branches are now to be dissected out. The zygomatic nerve will be seen along the lower part of the lateral wall of the orbit.

Maxillary Nerve (Superior maxillary nerve).—The origin of the nerve from the semilunar ganglion and its course inside the cranium have been examined. It leaves the cranial cavity through the foramen rotundum and, crossing the upper part of the pterygopalatine fossa, inclines lateralwards and enters the orbit through the inferior orbital fissure. It then traverses the infraorbital canal in the floor of the orbit accompanied by the infraorbital vessels assuming the name of the *infraorbital nerve*.

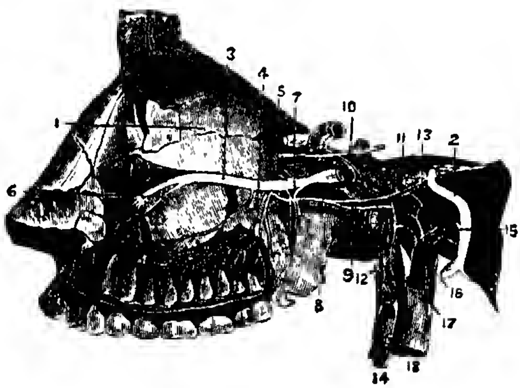


Fig. 106.—Dissection of the maxillary nerve and spheno-palatine ganglion (Hirschfeld and Leveille).

1. Medial wall of orbit
2. Facial nerve.
3. Maxillary nerve.
4. Posterior superior alveolar nerve.
5. Zygomatic branch (cut).
6. Anterior superior alveolar nerve.
7. Sphenopalatine ganglion.
8. Nerve of pterygoid canal.
9. Deep petrosal nerve,
10. Abducent nerve.
11. Greater superficial petrosal nerve.
12. Internal carotid plexus of sympathetic.
13. Lesser superficial petrosal nerve.
14. Superior cervical ganglion.
15. Chorda tympani nerve.
16. Tympanic branch of glosso-pharyngeal nerve.
17. Glossopharyngeal nerve.
18. Internal jugular vein.

It issues out of the infraorbital foramen and appears on the face (p. 275).

Branches.——(1) The *meningeal branch* given off within the cranium has been examined. (2) The *zygomatic nerve* (temporomalar nerve) arises from the maxillary nerve in the pterygopalatine fossa and, entering the orbit through the inferior orbital fissure, divides into two branches, the zygomatico-temporal and the zygomatico-facial. The *zygomaticotemporal branch* passes along the lateral wall of the orbit and receives a communicating filament from the lacrimal nerve. It issues out of the orbit through a foramen in the zygomatic bone and appears in the temporal fossa. Its distribution to the skin of the temporal region has been examined (p. 200). The *zygomaticofacial branch* also issues out of the orbit through a canal in the zygomatic bone and appears on the face (p. 275). (3) The *sphenopalatine branches*, two in number, descend to join the sphenopalatine ganglion and constitute its sensory roots. (4) The *posterior superior alveolar nerve* (posterior superior dental nerve) arises before the maxillary nerve enters the orbit. It divides into two branches which descend along the infratemporal surface of the maxilla and supply filaments to the gum and the mucous membrane of the cheek. They then enter the posterior alveolar canals and supply the lining membrane of the maxillary sinus (antrum of Highmore) and the three molar teeth. (5) The *middle superior alveolar nerve* arises from the infraorbital nerve at the back part of infraorbital canal and descends through a minute canal in the lateral wall of the maxillary sinus to supply the two premolar teeth. (6) The *anterior superior alveolar nerve* arises from the infraorbital nerve at the front part of the infraorbital canal. It descends through a minute canal in the anterior wall of the maxillary sinus and, after giving off a branch to the mucous membrane of the anterior part of the inferior meatus, supplies filaments to the incisor and canine teeth.

The *infraorbital artery* which accompanies the infraorbital nerve should be examined now. It is a branch of the internal maxillary artery given off in the pterygopalatine fossa. In the infraorbital canal it gives off the *anterior superior alveolar artery* which accompanies the nerve of the same name and has the same method of distribution. Its termination in the face has been examined. The *infraorbital vein* terminates in the pterygoid venous plexus.

THE NASAL CAVITIES

Dissection. The larynx and tongue with the loose piece of the mandible should now be removed from the front part of the skull and kept aside for subsequent examination. For this purpose it will be necessary to make a curved incision. Begin from the angle of the mouth and proceed backwards cutting through the buccinator, the mucous membrane of the cheek, the lateral wall of the pharynx and any vessels and nerves which stand in the way. The same thing is to be done from the angle of the mouth on the opposite side. The fore part of the skull should then be divided into two lateral halves by sawing it in the sagittal direction. First saw through the roof of the nasal cavity a little to the left of the middle line, so that the septum of the nose remains intact with the right half of the section. Place the roof of the mouth uppermost; divide the soft parts a little to the left of the middle line and saw through the hard palate and the alveolar process of the maxilla to complete the section.

The **Septum of the Nose** forms the medial wall of the nasal cavities. It is composed partly of bone and partly of cartilage. It is often deflected to one or the other side. The mucous membrane covering it is divisible into two parts: that covering the upper third of the septum is called the *olfactory area*, in which the branches of the olfactory nerves ramify; it is thinner than that covering the lower two thirds of the septum, called the *respiratory area*, which is very vascular and contains many mucous glands. On the lower and anterior part of the septum, a minute orifice leading into a blind canal, called the *vomeronasal organ of Jacobson*, is seen. This organ corresponds to a similar highly developed structure seen in many lower animals.

Directions. The student should next study the constituent parts of the nasal septum. The mucous membrane is to be removed from the whole of the left side of the septum. A macerated skull with the nasal septum exposed should be procured which will facilitate the study of the dissected part.

Formation of the nasal septum.—The bones entering into its formation are the crest of the nasal bones and the frontal spine in front; the perpendicular lamina of the ethmoidal bone in the middle, the vomer and the rostrum of the sphenoidal bone behind; and the crest formed by the palatine bones and the palatine processes of the maxillary bones below. The triangular

gap left in front between the vomer and the perpendicular lamina of the ethmoidal bone is filled up by the *septal cartilage.* This cartilage is somewhat quadrilateral in shape. Its postero-superior border joins the perpendicular lamina of the ethomidal bone. Its postero-inferior border joins the vomer and the incisive crest of the maxillæ. Its antero-superior border joins the nasal bones above and the lateral cartilages of the nose below. Its antero-inferior border is connected in front with the medial crura of the greater alar cartilages by fibrous tissue.

Dissection. Remove the septal cartilage and the thin bones forming the septum of the nose; detach them from the mucous membrane lining their right lateral surface. Trace the blood vessels and nerves of the septum in the mucous membrane.

Nerves of the Nasal Septum.—The *olfactory nerves* descend through the medial row of foramina in the cribriform plate of the ethmoidal bone and supply the upper third of the mucous membrane lining the septum.

The *nasopalatine nerve* is a branch of the sphenopalatine ganglion. It enters the nasal cavity through the sphenopalatine foramen and reaches the septum by passing medialwards across the roof of the cavity. It then passes downwards and forwards grooving the surface of the vomer and leaves the nasal cavity through the incisive canal. In the roof of the mouth it supplies the mucous membrane covering the hard palate and communicates with the anterior palatine nerve and with its fellow of the opposite side.

The *posterior superior nasal branches* are minute twigs which arise from the sphenopalatine ganglion. They enter the nasal cavity through the sphenopalatine foramen and supply the upper and back part of the septum of the nose. The *internal nasal branches* of the anterior ethmoidal nerve supply the front part of the septum of the nose. The *nasal branches* derived from the nerve of the pterygoid canal supply the upper and back part of the septum.

The arteries of the nasal cavities are very small and can be distinctly seen in well injected bodies.

Arteries of the Nasal Septum.—These are: (1) *the posterior septal branch* which is the continuation of the sphenopalatine artery and accompanies the nasopalatine nerve; (2) the *nasal branch of the anterior ethmoidal artery* which supplies the front part of the nasal septum; (3) the *nasal branches of the posterior*

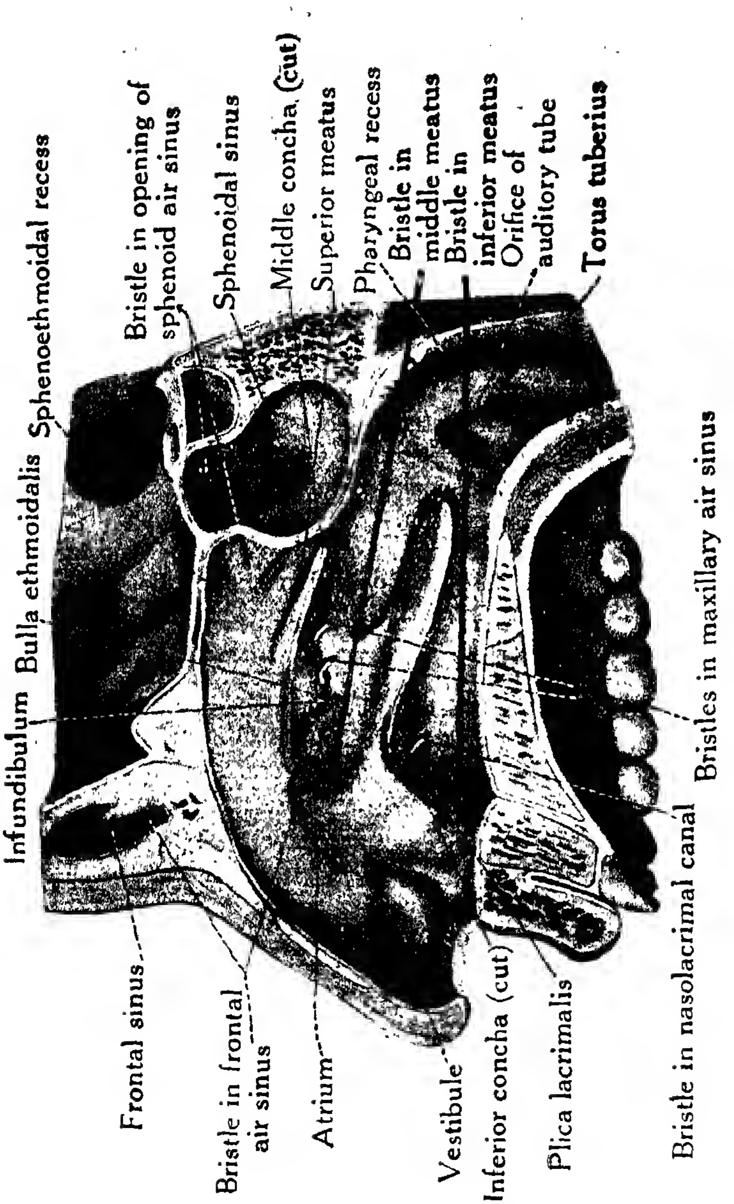


Fig. 107.—The lateral wall of the nasal cavity (Sobotta).

ethmoidal artery which descend through the foramina in the lamina cribrosa of the ethmoidal bone and supply the upper part of the nasal septum; and (4) the *septal branch of the superior labial artery* which supplies the front part of the nasal septum.

Dissection. Remove the mucous membrane lining the right side of the nasal septum keeping the nasopalatine nerve intact. The right nasal cavity is now exposed.

Nasal Cavities.—Each nasal cavity presents for examination a medial wall or septum, a lateral wall, a roof, a floor, an anterior aperture or nostril, and a posterior aperture or choana. The bony boundaries of the nasal cavities should be studied from a macerated skull.

The **Lateral Wall** of the nasal cavity presents in the recent state in front a depression which forms the lateral part of the vestibule of the nose. It is lined by skin bearing coarse hairs called *vibrissæ*. Behind the vestibular part, the lateral wall presents three elevations covered by mucous membrane. They are called from above downwards the *superior, middle* and *inferior nasal conchæ*. There are recesses below and lateral to these conchæ called the *meatuses*. The student should note that of the three conchæ the superior and middle are parts of the ethmoidal bone while the inferior concha is an independent bone. Above the superior concha is a depression, called the *sphenoethmoidal recess*, into which the sphenoidal sinus opens. The *superior meatus* is a small fissure between the superior and the back part of the middle conchæ. Into its front part the posterior ethmoidal cells open by one or two small apertures. The *middle meatus* is situated between the middle and inferior conchæ. It leads in front into a depression above the vestibule called the *atrium* of the middle meatus which is bounded above by a ridge called the *agger nasi*. Above and in front the middle meatus leads into a funnel-shaped passage called the *infundibulum* by means of which it communicates with the frontal sinus. On raising or cutting away the middle nasal concha a deep curved grove will be seen on the lateral wall of the middle meatus. This groove is called the *hiatus semilunaris* and in it are seen the openings of the anterior ethmoidal cells and the maxillary sinus. Fine probes may be passed through these openings to ascertain their direction. Above the hiatus semilunaris is a rounded elevation called the *bulla ethmoidalis*. The middle ethmoidal cells open either on or above the bulla by an aperture. The *inferior meatus* is the longest of the three meatuses. The

nasolacrimal duct opens into its front part. A fine probe may be passed through the nasolacrimal duct from above to ascertain the situation of the opening.

The *roof* of the nasal fossa is narrow ; it is horizontal in the middle and sloping both anteriorly and posteriorly. Its *floor* is wide, being concave from side to side. The anterior apertures or *nostrils* are oval and open on the face. The posterior apertures or *choanæ* open into the nasal part of the pharynx. The mucous membrane lining the lateral wall is divisible into an upper or olfactory portion which lines the superior nasal concha ; and a lower or respiratory portion which lines the remaining part of the lateral wall. The respiratory portion of the mucous membrane is thick, very vascular and contains numerous mucous glands.

Nerves in the lateral wall of the nasal cavity.—To expose these nerves the mucous membrane is to be removed without injuring the nerves and blood vessels ramifying in it. (1)The *olfactory nerves* are fine filaments which ramify on the superior concha and pass through the foramina in the cribriform lamina of the ethmoidal bone to join the olfactory bulb. (2) The *anterior ethmoidal nerve* will be seen in the groove on the medial surface

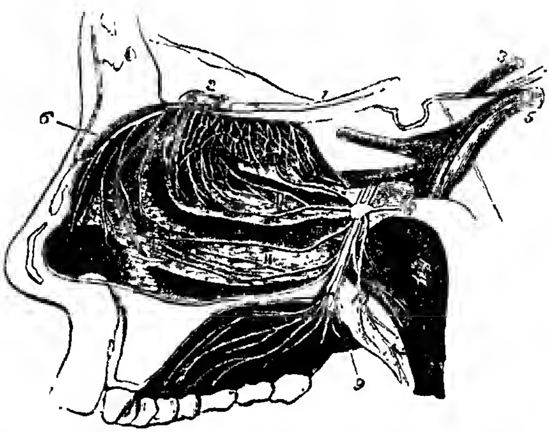


Fig. 108.—Nerves of the lateral wall of the nasal cavity and of the palate (Ellis).

1. Olfactory tract.
2. Olfactory bulb giving branches to the nasal cavity.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Trigeminal nerve.
6. Nasociliary nerve.
7. Sphenopalatine ganglion.
8. Nerve of pterygoid canal.
9. Anterior palatine nerve.
10. Posterior palatine nerve.
11. Posterior inferior nasal branches.

of the nasal bone and from it internal nasal branches pass to supply the mucous membrane of the front part of the lateral wall. (3) The *posterior superior nasal branches* of the spheno-palatine ganglion enter through the sphenopalatine foramen and supply the mucous membrane covering the superior and middle nasal conchæ. (4) The *nasal branch* of the anterior superior alveolar nerve enters the inferior meatus of the nose through an aperture in its lateral wall and supplies the mucous membrane of the front part of the meatus. (5) The *posterior inferior nasal branches* of the anterior palatine nerve are two in number; they enter the back part of the lateral wall through apertures in the perpendicular plate of the palatine bone. They supply the mucous membrane over the back part of the inferior nasal concha and the middle and inferior meatuses.

The **Arteries** supplying the lateral wall are (1) the posterior lateral nasal branches of the sphenopalatine artery and (2) the nasal branches of the anterior and posterior ethmoidal arteries.

SPHENOPALATINE GANGLION. TERMINAL PART OF THE INTERNAL MAXILLARY ARTERY.

Dissection. To expose the sphenopalatine ganglion the remains of the mucous membrane on the lateral wall of the nasal cavity at its back part should be removed, care being taken to preserve the nasopalatine nerve and the posterior superior nasal branches of the ganglion. The sphenopalatine foramen is to be looked for; just lateral to this foramen the ganglion is situated. The thin plate of bone forming the medial wall of the pterygopalatine canal is to be removed with a fine chisel carefully to lay open the canal. The anterior palatine nerve contained within this canal, if traced upwards will lead to the ganglion. The two sphenopalatine branches which descend from the maxillary nerve as it crosses the upper part of the pterygopalatine fossa will also lead to the ganglion. By chipping away the orbital process of the palatine bone and a part of the body of the sphenoidal bone the ganglion will be more satisfactorily exposed. The terminal part of the internal maxillary artery with its branches will also be displayed in this dissection.

The **Sphenopalatine Ganglion** (Meckel's ganglion) is triangular in shape and placed in the sphenopalatine fossa just lateral

to the sphenopalatine foramen (Fig. 106). It is surrounded by the branches of the terminal portion of the internal maxillary artery. Its *sensory roots* are derived from the two spheno-palatine branches of the maxillary nerve, which join it from above. Its *parasympathetic* and *sympathetic roots* are derived through the nerve of the pterygoid canal which join the ganglion posteriorly. The nerve of the pterygoid canal is formed by the union of the greater superficial petrosal and deep petrosal nerves ; of these the former contains parasympathetic fibres from the facial nerve and the latter contains sympathetic fibres from the internal carotid plexus.

The *branches* of the sphenopalatine ganglion are :—(1) The *posterior superior nasal branches* which arise from the medial aspect of the ganglion and enter the nasal cavity through the sphenopalatine foramen. The largest of these branches is called the *nasopalatine nerve*. It crosses the roof of the nasal cavity medialwards. Its course along the septum of the nose has been examined. The smaller posterior superior nasal branches supply the back part of the septum and the lateral wall of the nasal cavity. (2) The *pharyngeal nerve* arises from the posterior part of the ganglion and passes through the pharyngeal canal to supply the mucous membrane of the nasal part of the pharynx. (3) The *orbital branches* are two or three filaments which enter the orbit through the inferior orbital fissure to supply the periosteum of the orbit. (4) The *palatine nerves* are three in number : anterior, middle and posterior. They arise from the lower part of the ganglion. The *anterior palatine nerve* descends through the pterygopalatine canal and, entering the hard palate through the greater palatine foramen, passes forwards and supplies the mucous membrane of the hard palate and the gums. It communicates near the incisive foramen with the terminal filaments of the nasopalatine nerve. It gives off *posterior inferior nasal branches* which enter the lateral wall of the nasal cavity through apertures in the vertical plate of the palatine bone. The *middle palatine nerve* issues out of one of the lesser palatine foramina in the pyramidal process of the palatine bone and supplies the soft palate and the tonsil. The *posterior palatine nerve* emerges through a separate lesser palatine foramen behind and lateral to the preceding and supplies the soft palate and tonsil.

Dissection. Attempt should now be made to open up the pharyngeal and pterygoid canals and the lower part of the

pterygopalatine canal to see the passage of the nerves through them.

Internal Maxillary Artery.—The third or terminal portion of the artery lies in the pterygopalatine fossa and gives off the following branches :—(1) The ***posterior superior alveolar artery*** (posterior dental artery) which descends along the infratemporal surface of the maxillary bone and sends twigs through the alveolar canals to supply the molar and premolar teeth and the lining of the maxillary sinus. Some twigs pass forwards to supply the gums. (2) The ***infraorbital artery*** passes forwards to the orbit through the inferior orbital fissure. It accompanies the infraorbital nerve and appears on the face through the infraorbital foramen. (3) The *descending palatine artery* descends through the pterygopalatine canal with the anterior palatine nerve and gives off smaller palatine arteries which accompany the middle and posterior palatine nerves to the soft palate and palatine tonsil. The remaining portion of the artery is called the *great palatine artery* which emerges from the greater palatine foramen and passes forwards to the incisive foramen through which it ascends to anastomose with the terminal part of the nasopalatine artery. Its branches are distributed to the gums, mucous membrane and glands of the palate. (4) The *artery of the pterygoid canal* (Vidian artery) passes backwards in company with the nerve of the same name, through the pterygoid canal and supplies the mucous membrane of the nasal part of pharynx and the auditory tube and with it sends a twig to supply the tympanic cavity. (4) The *pharyngeal artery* passes backwards through the pharyngeal canal and is distributed like the preceding artery. (5) The *sphenopalatine artery* passes medialwards and enters the nasal cavity through the sphenopalatine foramen. Its course in the nasal cavity has been examined (p. 361).

THE TONGUE

The tongue is a muscular organ covered by mucous membrane and is placed on the floor of the mouth. It is the chief organ of taste, speech, mastication and deglutition. The following parts of the tongue should be identified : (1) the *body* which forms the bulk of the organ. (2) The *base* or *root* which forms the posterior end of the organ and is attached to the hyoid bone. (3) The *dorsum* or upper surface is divided into two symmetrical halves by a median groove which terminates posteriorly in a pit

called the *foramen cæcum.* From this foramen a V-shaped groove extends forwards and lateralwards to the margins of the tongue. This groove is called the *sulcus terminalis.* (4) The *apex* or tip is the free anterior extremity and touches the incisor teeth. (5) The *lower surface* is seen on turning up the apex and lies upon the floor of the mouth. (6) The *lateral margins* are rounded and separate the upper from the lower surface.

The *mucous membrane* of the tongue covers the whole of the organ. On the lower surface of the tongue it forms in the middle line a fold, the *frenulum linguæ,* which connects the organ to the floor of the mouth. On either side of the frenulum a fold of mucous membrane, called the *plica fimbriata,* extends anteroposteriorly, the free margin of which presents a series of fringe-like processes. Small projections, called the *papillæ* of the tongue, are thickly distributed in the mucous membrane covering the dorsum of the tongue in front of the sulcus terminalis. Behind the sulcus terminalis the mucous membrane presents a large number of small lymphoid nodules which collectively are known as the *lingual tonsil;* it is continued on to the epiglottis being raised into a fold called the *glosso-epiglottic fold.*

Papillæ of the Tongue.—These are of four kinds, viz., vallate, fungiform, conical and filiform. The *papillæ vallatæ,* (circum-vallate), eight to twelve in number, are of large size and are arranged at the back part of the dorsum of the tongue like the limbs of the letter V in front of the sulcus terminalis. The free end of each papilla is broad, while the attached end is narrow and fixed to the bottom of a circular depression. This depression is surrounded by a slightly raised wall called the *vallum.* The *papillæ fungiformes* are smaller but more numerous than the papillæ vallatæ. They are found chiefly on the sides and tip of the tongue and sparingly over its dorsum. Each papilla has a rounded head and is distinguished during life by its bright red colour. The *papillæ conicæ* are smaller than the preceding but more numerous. They are small conical processes with pointed ends and are arranged in lines parrallel to those of the papillæ vallatæ, except at the tip of the organ where they are arranged more or less transversely. The *papillæ filiformes* are conical papillæ whose apices have been broken up into thread-like projections. They are found over the whole of the mucous membrane of the tongue and over the larger papillæ.

Muscles of the Tongue.—The substance of the tongue is composed of muscle fibres and some fatty tissue. In the median

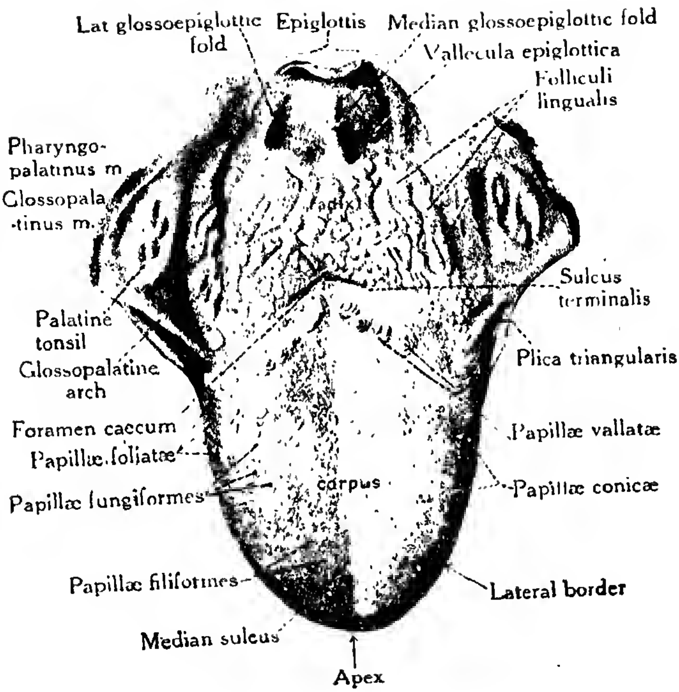


Fig. 109.—The tongue (Sobotta).

To face p. 364.

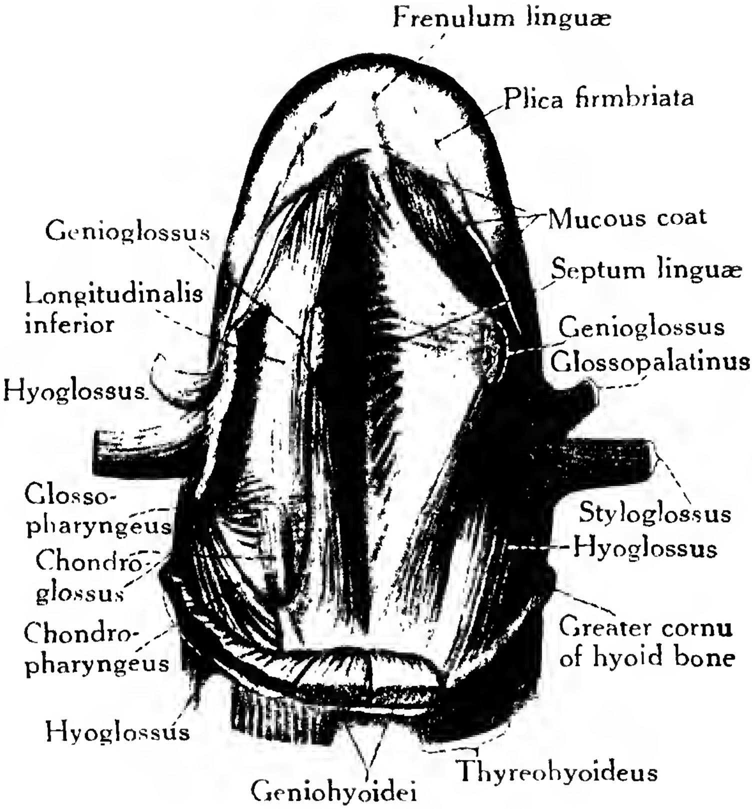


Fig. 113.—The extrinsic muscles of the tongue (Sobotta)

plane between the two halves of the tongue a fibrous septum is interposed. Each half is composed of two sets of muscles, extrinsic and intrinsic. The *extrinsic muscles* are inserted into the tongue having their origins outside the organ. These are the styloglossus, the glossopalatinus, the hyoglossus, the genioglossus and the chondroglossus. They have been already examined except the chondroglossus. The *intrinsic muscles* are entirely limited to the organ itself. They are the longitudinalis linguæ superior, the longitudinalis linguæ inferior, the transversus linguæ and the verticalis linguæ.

The *chondroglossus* is a slender muscle which arises from the medial aspect of the base of the lesser cornu and the contiguous part of the body of the hyoid bone. It passes upwards and blends with the intrinsic muscles of the tongue. It is separated from the hyoglossus by some fibres of the genioglossus. It helps to depress the tongue and is supplied by the hypoglossal nerve.

The *longitudinalis linguæ superior* lies longitudinally along the entire dorsal surface of the tongue immediately beneath the mucous membrane which should be removed to display the muscle. The *longitudinalis linguæ inferior* lies on the under surface of the tongue being placed between the hyoglossus and the genioglossus. It extends from the root of the organ to its tip where it blends with the styloglossus. The *transversus linguæ* will be seen by making a coronal section of the tongue. The transverse fibres composing it extend from the median septum transversely to the margins of the tongue. The *verticalis linguæ* will be seen in the same section. The fibres composing it run from the dorsum to the lower surface of the organ decussating with the fibres of the transversus. The four intrinsic muscles are supplied by the hypoglossal nerve. They alter the shape of the tongue; the superior and inferior shorten it, the transverse elongates it, and the vertical widens it.

The **Nerves of the Tongue** are (1) the *hypoglossal* which is the motor nerve of the tongue; (2) the *lingual* which is the nerve of general sensibility for the anterior two-thirds of the organ; the *chorda tympani nerve* which is carried with the lingual nerve is a nerve of taste for this part of the tongue; (3) the *glossopharyngeal nerve* which is the nerve of taste and general sensibility for the posterior third of the dorsum and sides of the tongue; (4) the *internal laryngeal nerve* which supplies the mucous membrane at the base of the tongue in front of the epiglottis. All

these nerves should now be traced further through the substance of the organ to their terminations.

THE LARYNX

Directions. The remains of the mandible still attached to the part which has been examined should now be removed.

The Larynx is the upper dilated portion of the windpipe in which voice is produced. It is placed opposite the fourth, fifth and sixth cervical vertebræ but its position varies owing to the fact that it is a very movable organ. In the male its length is about an inch and three-quarters ; its width is about the same at the top but is only about an inch at the lower end. In the female it is about an inch and a half long. Before puberty it is very small. *In front* it is covered by the fascia colli, the sternohyoideus, sternothyreoideus, the thyreohyoideus, superior belly of the omohyoideus and the pyramidal process of the thyreoid gland. *On each side* it has the great vessels of the neck and the lateral lobe of the thyreoid gland. *Behind* it is the pharynx. *Below* it is continuous with the trachea. *Above* it communicates with the pharynx by an opening called the entrance into the larynx.

The *entrance into the larynx* (*aditus laryngis*) is somewhat triangular in shape, being broad in front and narrow behind. It slopes rapidly from above downwards and backwards. In front it is bounded by the epiglottis, laterally by the aryepiglottic folds and behind by the apices of the arytænoid cartilages and the corniculate cartilages.

Dissection. The ligaments and intrinsic muscles of the larynx should now be examined by fixing the organ with pins. Remove the thyreoid gland and also the extrinsic muscles of the larynx, viz., the sternohyoideus, the sternothyreoideus, the thyreohyoideus and the inferior constrictor of the pharynx. Preserve the external and internal laryngeal nerves, the recurrent nerve and the superior and inferior laryngeal vessels.

The **Hyothyreoid Membrane** is a fibro-elastic structure connecting the hyoid bone to the thyreoid cartilage. It consists of a central portion and two rounded lateral portions called the lateral hyothyreoid ligaments. The central portion is attached above to the upper margin of the posterior surface of the body and greater cornu of the hyoid bone and below to the upper border of the thyreoid cartilage ; a mucous bursa is interposed between the posterior surface of the body of the hyoid

bone and the membrane. The central portion of the membrane is thicker in the middle than at the sides. This thickened portion is called the *middle hyothyreoid ligament*. The thinner lateral portion is perforated by the superior laryngeal vessels and the internal laryngeal nerve. The *lateral hyothyreoid ligaments* are two rounded cords ; each of them extends from the tip of the greater cornu of the hyoid bone to the superior cornu of the thyreoid cartilage and contains usually a small cartilaginous nodule called the *cartilago triticea*.

The **Cricothyreoideus** arises from the front and side of the arch of the cricoid cartilage. It is divisible into two portions, an anterior and a posterior. The anterior or *straight portion* consists of fibres which pass upwards and backwards to be inserted into the back part of the lower border of the thyreoid cartilage. The posterior or *oblique portion* consists of fibres which pass backwards and lateralwards to be inserted into the anterior border of the inferior cornu of the thyreoid cartilage. Between the anterior borders of the two cricothyreoid muscles is seen the middle cricothyreoid ligament. The cricothyreoid muscles are supplied by the external laryngeal nerves. When they contract the front part of the cricoid cartilage is raised and the upper border of its quadrilateral lamina with the arytænoid cartilages is tilted backwards rendering the vocal folds tense and elongated.

The whole of the cricothyreoid muscle overlapping the lateral portion of the conus elasticus is now to be removed.

The **Conus Elasticus** (cricothyreoid membrane) consists of an anterior triangular portion and two lateral portions. The anterior portion or *middle cricothyreoid ligament* is thick and is attached below by its broad end to the upper border of the anterior part of the cricoid arch and above by its narrow end to the front part of the lower border of the thyreoid cartilage. The *lateral portions* extend from the superior border of the cricoid cartilage beneath the mucous membrane of the larynx to the inferior margins of the vocal ligaments.

Dissection. To expose the cricoarytænoideus posterior and the arytænoideus, the mucous membrane covering the posterior surfaces of the cricoid and arytænoid cartilages is to be removed. The mucous membrane of the aryepiglottic fold is also to be removed from the lateral aspect to expose the aryepiglottic muscle.

The **Cricoarytænoideus Posterior** arises from the depression

on the posterior surface of the quadrilateral portion of the cricoid cartilage. From this origin the fibres converge to be inserted into the back part of the muscular process of the arytænoid cartilage. The posterior cricoarytænoid muscles are supplied by the recurrent nerves and they open the glottis by rotating the vocal processes lateralwards.

The **Arytænoideus** extends between the posterior surfaces of the arytænoid cartilages. It consists of two portions, an oblique and a transverse. The *arytænoideus obliquus* is superficial and consists of two bundles of fibres. Each bundle passes from the back part of the muscular process of the arytænoid cartilage obliquely upwards to the apex of the opposite arytænoid cartilage. These two bundles cross each other along the middle line like the limbs of the letter **X**. From the apices of the arytænoid cartilages some fibres are prolonged to the margins of the epiglottis along the aryepiglottic folds forming *aryepiglotticus muscles*. The *arytænoideus transversus* is the only unpaired muscle of all the intrinsic muscles of the larynx and consists of transverse fibres lying beneath the oblique muscle. The fibres extend from the posterior surface and lateral border of one arytænoid cartilage to the corresponding parts of the other cartilage. The arytænoidei are supplied by the recurrent nerves and the internal laryngeal nerve. They narrow the opening of the glottis by approximating the arytænoid cartilages.

Dissection. Open up the larynx from behind by cutting with scissors vertically along the middle line through the interval between the two arytænoid cartilages and through the quadrilateral portion of the cricoid cartilage.

The *mucous membrane* of the larynx is continuous above with that of the pharynx and below with that of the trachea. It presents on either side two more or less crescentic folds, an upper and a lower, running from before backwards. The upper one is called the ventricular fold and the lower one, the vocal fold. The *ventricular fold* (false vocal cord) encloses a fibrous band, called the ventricular ligament, and will be examined later. Its free crescentic margin is directed downwards. The *vocal fold* (true vocal cord) produces voice by its vibrations. It encloses an elastic ligamentous band, called the *vocal ligament*, and the musculus vocalis lies lateral to it. It extends from the processus vocalis of the arytænoid cartilage to the angle of the thyreoid cartilage. Its upper free margin forms the lower boundary of the ventricle of the larynx.

Fig. 111.—Posterior view of the larynx.

Fig. 112.—Side view of the larynx.

Fig. 113.—The cricothyreoid muscle and ligament.

(Sobotta)

To face p. 368.

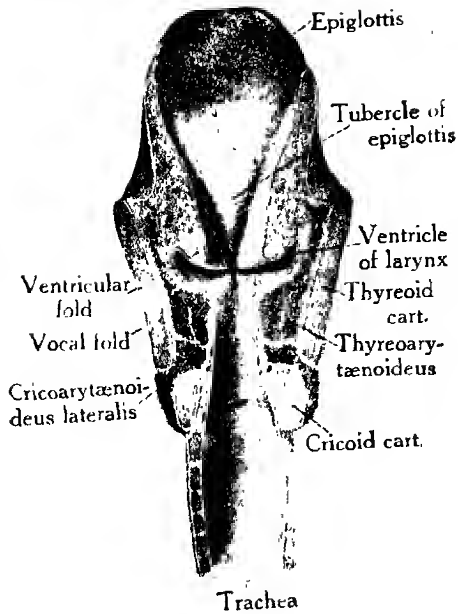


Fig. 114.—Coronal section of the larynx and upper part of trachea (Sobotta).

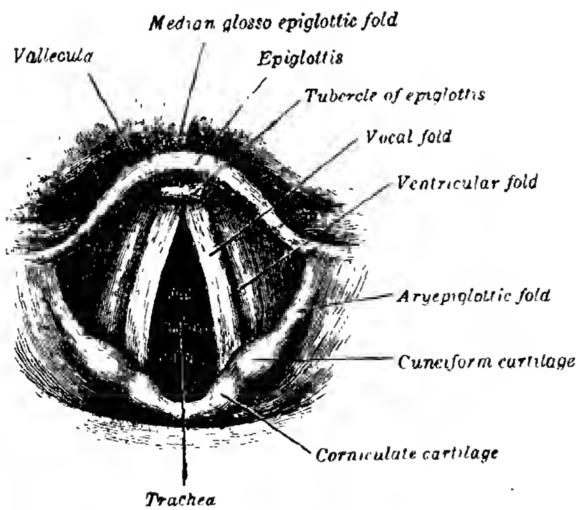


Fig. 115.—Laryngoscopic view of the interior of the larynx (Gray).

The *ventricle of the larynx* is the fossa in each lateral wall of the larynx lying between the ventricular fold above and the vocal fold below. Lateral to it is the lamina of the thyreoid cartilage lined by mucous membrane. From the anterior end of the fossa a diverticulum passes upwards lateral to the anterior end of the ventricular fold. This pouch is called the *appendix of the laryngeal ventricle* (laryngeal saccule).

The **Cavity of the Larynx** is divided into two portions, an upper and a lower, by the projections of the vocal folds. The upper portion lies above the level of these folds and is called the *vestibule*. The vestibule is broad above but narrow below and presents in its anterior wall an elevation caused by the tubercle of the epiglottis. The lower portion is narrow and elliptical above but broad and circular below where it is continuous with the trachea. The narrow chink or fissure between the vocal folds by which the vestibule communicates with the lower portion of the larynx is called the rima glottidis.

The *rima glottidis* is the elongated fissure bounded on either side by the vocal folds in front, and the bases and vocal processes of the arytænoid cartilages behind. Posteriorly it is limited by the mucous membrane passing between the arytænoid cartilages. The front portion of it lying between the vocal folds is called the *intermembranous portion* (glottis vocalis) ; and the hind portion of it lying between the arytænoid cartilages is called the *intercartilaginous portion* (glottis respiratoria). The size of the rima glottidis differs in the two sexes and its shape varies with the movements of the vocal folds and arytænoid cartilages which occur during respiration and phonation. In the male it measures about an inch (2.5 cm.) and in the female about three-fourths of an inch (2 cm.).

Dissection. To expose the remaining intrinsic muscles of the larynx, the right lateral portion of the hyothyreoid membrane and the conus elasticus are to be divided. The right inferior cornu of the thyreoid cartilage is to be disarticulated from the cricoid cartilage and the right lamina of the thyreoid cartilage is to be divided a little to the right side of the middle line. Reflect this loose piece of the right lamina of the thyreoid cartilage forwards detaching the muscles and mucous membrane from its inner surface. The lateral cricoarytænoid, thyreoarytænoid and thyreoepiglottic muscles are now exposed.

The **Cricoarytænoideus Lateralis** arises from the upper border of the arch of the cricoid cartilage. The fibres pass

upwards and backwards to be inserted into the front aspect of the muscular process of the arytænoid cartilage. The lateral cricoarytænoid muscles are supplied by the recurrent nerves and they help to close the glottis.

The **Thyreoarytænoideus** arises from the lower half of the angle of the thyreoid cartilage and from the middle cricothyreoid ligament and is inserted into the base and antero-lateral surface of the arytænoid cartilage. The thyreoarytænoidei are supplied by the recurrent nerves and they approximate and relax the vocal folds.

The **Thyreoepiglotticus** arises from the medial surface of the lamina of the thyreoid cartilage above the attachment of the thyreoarytænoideus. It passes upwards and backwards to the aryepiglottic fold and is inserted into the side of the epiglottis at its lower part. The thyreoepiglottici are supplied by the recurrent nerves and they widen the laryngeal aperture and the vestibule.

Dissection. Remove the fibres of the thyreoarytænoideus. The musculus vocalis is exposed.

The **Musculus Vocalis** lies deep to the lower fibres of the thyreoarytænoideus and extends from the angle of the thyreoid cartilage to the lateral surface of the vocal process and the adjoining antero-lateral surface of the arytænoid cartilage. Some of its fibres are inserted into the vocal ligament which lies parallel to its medial surface. The vocales are supplied by the recurrent nerves and they approximate and relax the vocal folds.

Dissection. Remove the musculus vocalis and the thyreoepiglottic muscle. The vocal and ventricular ligaments and the outer surface of the conus elasticus are exposed.

The *vocal ligament* is a thickened band of elastic tissue enclosed between the two layers of the vocal fold. It is attached in front (close to its fellow of the opposite side) to the angle of the thyreoid cartilage and behind to the vocal process of the arytænoid cartilage. Below it is continuous with the lateral portion of the conus elasticus. The musculus vocalis lies lateral and parallel to it.

The *ventricular ligament* is a weak band of fibrous tissue enclosed between the two layers of the ventricular fold. It is attached in front to the angle of the thyreoid cartilage below the attachment of the epiglottis. Behind it is attached to the antero-lateral surface of the arytænoid cartilage above the attachment of the vocal ligament.

Dissection. The left side of the larynx has been reserved for the dissection of the nerves and vessels. The left half of the thyreoid cartilage is to be disarticulated from the cricoid, care being taken of the recurrent nerve which lies behind the joint between these two. After the thyreoid cartilage has been drawn away from the cricoid cartilage, the recurrent nerve which is accompanied by the inferior laryngeal artery, is to be fully dissected out. The internal laryngeal nerve, which is accompanied by the superior laryngeal artery, and its three branches are to be followed to the mucous membrane of the larynx.

The **Nerves of the Larynx** are :—(1) The *internal laryngeal branch* of the superior laryngeal nerve which pierces the lateral portion of the hyothyreoid membrane and breaks up into three branches. The upper branch supplies the mucous membrane lining the epiglottis and the aryepiglottic fold ; the middle branch supplies the mucous membrane over the side wall of the larynx ; and the lower branch descends beneath the mucous membrane lining the lamina of the thyreoid cartilage, supplies a twig to the arytænoideus and communicates with the recurrent nerve. (2) The *external laryngeal branch* of the superior laryngeal nerve supplies the cricothyreoid muscle. (3) The *recurrent nerve* enters the interior of the larynx behind the articulation between the inferior cornu of the thyreoid cartilage and the cricoid cartilage. It communicates with the lower branch of the internal laryngeal nerve and divides into branches which supply all the muscles of the larynx except the cricothyreoideus and a part of the arytænoideus.It also supplies the mucous membrane below the vocal folds.

The **Vessels of the Larynx** are :—(1) The *superior laryngeal artery* is a branch of the superior thyreoid artery and accompanies the internal laryngeal branch of the superior laryngeal nerve to the interior of the larynx. (2) The *inferior laryngeal artery* is a branch of the inferior thyreoid artery. It accompanies the recurrent nerve to the interior of the larynx and supplies its mucous membrane and muscles.

Dissection. The mucous membrane and the muscles are now to be removed from the left side to expose the cartilages of the larynx and to define the ligaments binding them together. The corniculate cartilages surmounting the apices of the arytænoid cartilages should be defined and the cuneiform cartilages contained in the aryepiglottic folds should be secured. Before removing the mucous membrane covering the anterior surface of the

epiglottis, note that it is reflected on to the base and margins of the tongue forming the *middle* and *lateral glossoepiglottic folds.* The depression between the base of the tongue and the epiglottis on each side of the middle glossoepiglottic fold is called the *vallecula.*

The cartilages of the larynx are nine in number : three single, viz., the epiglottis, the thyreoid and the cricoid cartilages ; and three paired, viz., two arytænoid, two corniculate and two cuneiform cartilages.

The **Epiglottis** is a piece of yellow fibrocartilage which lies behind the tongue and projects over the entrance into the larynx like a valve. It is like an ovoid leaf in shape with its narrow end attached by the thyreoepiglottic ligament to the angle formed by the two laminæ of the thyreoid cartilage. Its broad end is rounded and free. The anterior surface at its upper part is covered by mucous membrane which is reflected on to the tongue forming the *glossoepiglottic folds.* Lower down the anterior surface is connected to the hyoid bone by the *hyoepiglottic ligament.* The posterior surface is concave from side to side and concavo-convex from above downwards. The lower part of this surface presents a projection called the *tubercle* or *cushion.* To its sides are attached the aryepiglottic folds.

The epiglottic ligaments are:—(1) The median and lateral glossoepiglottic folds, (2) the hyoepiglottic ligament, and (3) the thyreoepiglottic ligament. These have been described.

The **Thyreoid Cartilage** consists of two lateral plates, called the *laminæ,* which unite at an angle in front forming a projection in the middle line of the neck called the *laryngeal prominence* (pomum Adami). This prominence is more marked in males. Each lamina is quadrilateral in form presenting for examination four borders and two surfaces. The *superior border* is slightly convex and affords attachment to the hyothyreoid membrane. At the junction of the two laminæ at the superior border is a **V**-shaped notch called the *superior thyreoid notch.* The *inferior border* is slightly concave and gives attachment anteriorly to the middle cricothyreoid ligament and posteriorly to the crico-thyreoid muscle. A little behind the mid-point of this border is a tubercle called the *inferior tubercle.* The *anterior border* is fused with that of the other lamina in the middle line. The *posterior border* is thick and rounded and is prolonged above and below as the cornua. The *superior cornu* is long and gives attachment to the lateral hyothyreoid ligament. The *inferior*

cornu is short and has a facet on the medial side of its tip which articulates with the side of the cricoid cartilage. The *lateral surface* of each lamina presents in front of the root of the superior cornu a tubercle called the *superior tubercle.* From this tubercle a *ridge* runs downwards and forwards to the inferior tubercle. The ridge gives attachment to the sternothyreoid and the thyreohyoid muscles ; to the ridge and the portion of cartilage behind it is attached the inferior constrictor of the pharynx. The *medial surface* of each lamina is slightly concave and is covered by mucous membrane. To the angular depression formed by the union of the two laminæ in front are attached from above downwards: the thyreoepiglottic ligament, the ventricular and vocal ligaments, thyreoepiglottic and thyreoarytænoid muscles.

The hyothyreoid ligament connecting the thyreoid cartilage to the hyoid bone has been already described.

The **Cricoid Cartilage** resembles a signet ring in shape. It consists of two portions a quadrilateral part situated behind, called the lamina, and a narrow arch placed in front called the arch of the cricoid. The *lamina* is about an inch in length from above downwards and presents on its posterior surface a median vertical ridge to which one or two bands of the longitudinal muscle fibres of the œsophagus are attached. On either side of this ridge is a depression for the origin of the cricoarytænoideus posterior. The *arch* of the cricoid cartilage measures about a quarter of an inch vertically, and gives attachment by its outer surface to the cricothyreoidei in front and at the sides, and to the inferior constrictor of the pharynx behind. At the junction of the lamina with the arch there is a small circular facet on the outer surface for articulation with the inferior cornu of the thyreoid cartilage. The *superior border* of the cricoid cartilage is directed obliquely upwards and affords attachment, in front, to the middle cricothyreoid ligament ; at the sides, to the conus elasticus and cricoarytænoidei lateralis. Posteriorly it presents in the middle a notch and on either side of this an oval convex facet for articulation with the base of the arytænoid cartilage. The *inferior border* of the cricoid cartilage is horizontal and is connected to the first ring of the trachea by by the cricotracheal ligament.

The *ligaments* connecting the thyreoid and cricoid cartiages are :—(1) the conus elasticus, which has been already examined; (2) an articular capsule, which surrounds the articulation

between the inferior cornu of the thyreoid cartilage and the lateral surface of the cricoid cartilage ; the capsule is lined by a synovial stratum.

The **Arytænoid Cartilages**, two in number, are pyramidal in shape and surmount the lamina of the cricoid cartilage. Each cartilage presents for examination three surfaces, a base and an apex. The *posterior surface* is concave and gives attachment to the arytænoideus. The *antero-lateral surface* is rough and gives attachment to the ventricular ligament and to the vocalis and thyreoarytænoid muscles. The *medial surface* is smooth and flat and covered by mucous membrane. The *base* is concave and presents an articular facet for the cricoid cartilage. It presents two prominent angles. The anterior angle or *vocal process* is pointed ; it projects forwards and gives attachment to the vocal ligament. The lateral angle or *muscular process* is rounded ; it projects backwards and lateralwards and gives attachment to the cricoarytænoideus lateralis in front and the cricoarytænoideus posterior behind. The *apex* is directed upwards, backwards and medialwards and is surmounted by the corniculate cartilage.

The *ligaments* connecting the arytænoid cartilage with the cricoid are :—(1) an articular capsule, which surrounds the articular surfaces at the base of the arytænoid cartilage and the superior border of the lamina of the cricoid cartilage ; it is lined by a synovial stratum ; (2) the conus elasticus, which connects the two cartilages.

The **Corniculate Cartilages** (cartilages of Santorini) are two small conical cartilaginous nodules which articulate with the summits of the arytænoid cartilages.

The **Cuneiform Cartilages** (cartilages of Wrisberg) are two elongated cylindrical nodules of elastic cartilage, placed one on each side, in the aryepiglottic fold.

THE EAR

The ear or organ of hearing is divisible into three portions : the external ear, the middle ear, and the internal ear. The external ear consists of the pinna and the external acoustic meatus. The pinna has been described (p. 261).

Dissection. To study the external acoustic meatus the following dissection is necessary. Remove the soft parts attached to the temporal bone. Clean the cartilaginous portion of the auditory tube and disarticulate the petrous portion of the

temporal bone from the sphenoid. Remove the squamous portion of the temporal bone by a saw-cut passing in front of the petrotympanic fissure. Cut away with bone forceps the anterior wall of the external acoustic meatus till the membrana tympani at the bottom of the meatus is clearly seen.

The **External Acoustic Meatus** (External auditory meatus) is the passage which extends from the bottom of the concha to the tympanic membrane. It is about an inch in length, if measured from the bottom of the concha and is directed forwards and medialwards. In its course it presents a curve the convexity of which is directed upwards. Its medial two-thirds is bony whereas the lateral third is cartilaginous. The deficiency in the cartilaginous wall at the upper and back parts is filled up by fibrous membrane. The bony portion of the canal is narrower than the cartilaginous portion and the narrowest part of the canal, called the *isthmus*, is seen about one-fifth of an inch lateral to the membrana tympani. The medial end of the canal is closed by the membrana tympani which is placed obliquely in such a way that the anterior wall and the floor of the canal are longer than the posterior wall and the roof. The skin lining the external

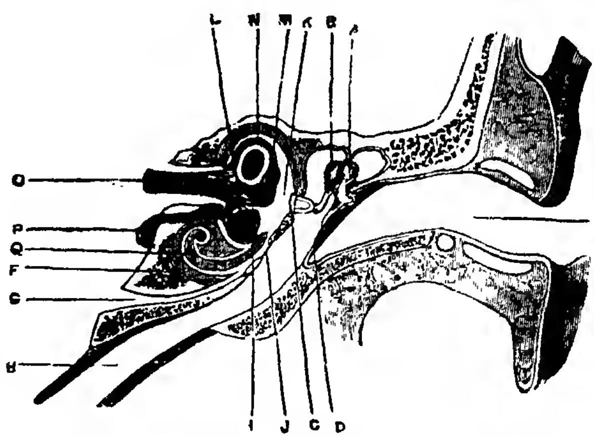


Fig. 116.—Diagram of the auditory apparatus (after Poirier).

A. Malleus.
B. Incus.
C. Stapes.
D. Membrana tympani.
E. External acoustic meatus.
F. Cochlea.
G. Aqueductus cochleæ.
H. Auditory tube.
I. Scala tympani.
J. Fenestra cochlearis.
K. Perilymph in vestibule.
L. Saccule.
M. Utricle.
N. Superior semicircular canal.
O. Acoustic nerve.
P. Saccus endolymphaticus.
Q. Cochlear canal.

acoustic meatus is prolonged over the lateral surface of the membrana tympani as a thin cuticular layer. In the cartilaginous portion of the canal the skin is covered with hair.

The **Membrana Tympani** is an oval membrane forming the medial boundary of the external acoustic meatus and placed obliquely from above downwards and forwards so as to form an acute angle with the floor of the canal. Its lateral surface is concave ; its medial surface is convex, and the point of its greatest convexity is called the *umbo*. The handle of the malleus descends through the medial surface of the membrane and shines through it. The tip of the handle lies opposite the umbo. The circumference of the membrane is fixed to the *sulcus tympanicus* except at the upper part where a gap exists in the sulcus called the *incisura tympanica* (notch of Rivinus). From the anterior and posterior ends of this notch two thickened folds, called the *anterior* and *posterior malleolar folds*, converge to the lateral process of the malleus projecting a little below the notch. The triangular piece of the membrana tympani included between the anterior and posterior malleolar folds and the incisura tympanica is loose and hence called the *pars flaccida ;* the greater portion of the membrane is tense and is called the *pars tensa.*

Dissection. The tympanic cavity should now be opened from above. The whole of the tegmen tympani forming the roof of the tympanic cavity and lying lateral to the eminentia arcuata on the anterior surface of the petrous portion of the temporal bone is to be removed with chisel and bone forceps. When the tympanic cavity has been fully exposed open up the canal for the tensor tympani muscle up to the point where it enters the tympanum. The connection of the tympanic cavity with the tympanic antrum behind should also be displayed.

The **Tympanic Cavity** or **Middle Ear** is a small air-chamber placed between the membrana tympani and the internal ear ; the air is carried to it from the nasopharynx through the auditory tube. Its vertical and antero-posterior diameters are each about half an inch. Its transverse diameter is about a sixth of an inch. It is traversed by a chain of bones which extend from its lateral to its medial wall. It is lined by mucous membrane which is continuous with that of the pharynx through the auditory tube. The cavity is divisible into two parts, an upper part lying above the level of the membrana tympani, called the *attic* or *epitympanic recess*, and a lower part called the

tympanic cavity proper which lies medial to the membrana tympani on a level with it.

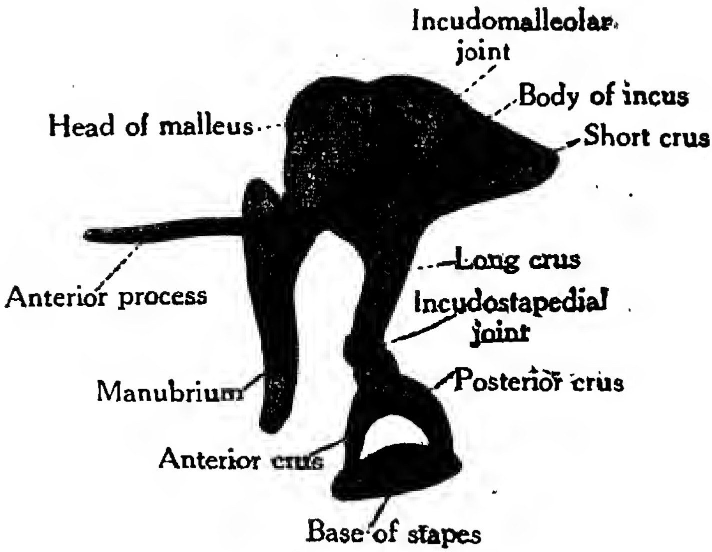


Fig. 117.—The auditory ossicles (Sobotta).

The tympanic cavity presents for examination a roof, a floor, and four walls. The *roof* is formed by a thin plate of bone, called the *tegmen tympani,* which separates the tympanum from the cranial cavity. The *floor* or *jugular wall* is formed by a thin plate of bone which separates the tympanic cavity from the jugular fossa ; it is interposed between the tympanic cavity and superior bulb of the internal jugular vein ; on it is seen a slit for the passage of the tympanic branch of the glossopharyngeal nerve. The *anterior* or *carotid wall* is narrow owing to the convergence of the medial and lateral walls and is formed by a lamina of bone which lies between the tympanic cavity and the carotid canal. At its upper part is seen the orifice of the semicanal for the tensor tympani muscle and below that the orifice of the auditory tube. These two orfices are separated from each other by a thin lamina of bone called the *septum canalis musculotubarii.* The *posterior* or *mastoid wall* presents (1) at its upper and lateral part an opening, called the *aditus,* which leads into the tympanic antrum ; (2) below the aditus, a hollow conical eminence called the *pyramid ;* (3) *fossa incudis,* which lodges the short crus of the incus. The antrum communicates with mastoid air

sinuses ; both are lined with mucous membrane continuous with that lining the tympanum. The pyramid presents a curved canal which contains the stapedius muscle ; its summit is perforated by a small aperture for the passage of the tendon of the muscle. The curved canal of the pyramid communicates behind with the facial canal and a twig from the facial nerve is given off within the facial canal to supply the stapedius inside the pyramid. At the junction of the posterior and lateral walls and at the upper part there is a minute aperture, called the *iter chordæ posterius*, through which the chorda tympani nerve enters the tympanic cavity. The *lateral* or *membranous wall* is formed chiefly by the tympanic membrane and the grooved ring of bone to which it is fixed. The *medial* or *labyrinthic wall* is formed by the lateral wall of the labyrinth. This wall presents for examination :—(1) A rounded eminence in front called the *promontory* caused by the first turn of the cochlea ; its surface presents furrows for the nerves of the tympanic plexus. (2) An oval opening is placed above the promontory, called the *fenestra vestibuli* (fenestra ovalis), which leads into the vestibule of the internal ear and is closed in the recent state by the stapes. (3) Another opening, called the *fenestra cochleæ* (fenestra rotunda) is situated below and behind the promontory ; it is closed in the recent state by a membrane called the *secondary tympanic membrane* but in the macerated bone it opens into the cavity of the cochlea. (4) The *eminence of the facial canal* indicates the position of the facial canal (aquæductus Fallopii), which contains the facial nerve and protrudes into the tympanum ; it extends along the medial wall from before backwards above the fenestra vestibuli.

The **Tympanic Antrum** (Mastoid antrum) is a large air-cavity in the mastoid portion of the temporal bone which communicates in front with the epitympanic recess of the tympanic cavity. It is bounded above by the tegmen tympani ; laterally, by the squamous portion of the temporal bone below the supramastoid crest ; medially, by the petrous part of the temporal bone in which is seen an eminence caused by the lateral semicircular canal ; below and behind, by the mastoid portion of the temporal bone in which are seen apertures of communication between the mastoid air cells and tympanic antrum.

The **Contents of the Middle Ear** are (1) the auditory ossicles, (2) the ligaments of the ossicles, (3) the muscles of the tympanic cavity, and (4) the nerves and (5) arteries, seen in the tympanic cavity.

The **Auditory Ossicles** are three in number, **viz., malleus,** incus and stapes.

The *malleus* resembles a hammer and consists of a head, a neck, and three processes, called the manubrium, the anterior and lateral processes. The *head* projects into the epitympanic recess and articulates by its posterior aspect with the incus. The articular surface is constricted in the middle. The *neck* is the constricted portion below the head. The *manubrium* is embedded throughout its entire length in the membrana tympani. The *anterior process* (processus gracilis) projects forwards from below the neck and is received into the petrotympanic fissure. The *lateral process* (processus brevis) projects lateralwards from the root of the manubrium and rests against the tympanic membrane below the membrana flaccida.

The *incus* resembles an anvil and consists of a body and two crura. The *body* articulates in front with the head of the malleus. The *short crus* passes almost horizontally backwards and lies against the posterior wall of the tympanum to which it is held by a ligament. The *long crus* descends vertically and at its lower end is bent medialwards terminating in a rounded knob, called the *lenticular process*, which articulates medially with the head of the stapes.

The *stapes* resembles a stirrup and presents a head, neck, two crura, and a base. The *head* presents a concave facet laterally for articulation with the lenticular process of the incus. The *neck* is the constricted part between the head and the crura and to it is inserted the stapedius muscle. Of the two *crura* the anterior is shorter and less curved than the posterior. The *base* is an oval plate of bone which connects the crura and is received in the fenestra vestibuli ; to the margin of which it is attached by an annular ligament. The upper margin of the base is convex and the lower almost straight.

The **Ligaments of the Auditory Ossicles** :—There are two *articular capsules ;* one surrounds the articulation between the head of the malleus and the body of the incus ; the other surrounds the articulation between the head of the stapes and the lenticular process of the incus. The malleus is connected with the wall of the tympanic cavity by three ligaments. (1) The *anterior ligament of the malleus* connects its anterior process to the petrotympanic fissure. (2) The *lateral ligament of the malleus* connects its lateral process to the incisura tympanica. (3) The *superior ligament of the malleus* connects the head of the malleus

to the roof of the tympanum. The incus is connected to the tympanic wall by the *ligament of the incus* which fixes its short crus to the posterior wall of the tympanic cavity. The ***annular ligament of the stapes*** connects the margin of the base of the stapes to the circumference of the fenestra vestibuli.

The **Muscles of the tympanic cavity** are two in number, the tensor tympani and the stapedius.

The *tensor tympani* arises from the cartilaginous portion of the auditory tube, from the adjoining part of the sphenoidal bone and from the wall of the bony canal in which it is contained. It passes backwards and lateralwards through the canal for it above the bony part of the auditory tube. Entering the tympanic cavity its tendon turns abruptly lateralwards to be inserted into the medial aspect of the manubrium of the malleus near its root. It is supplied by a branch from the otic ganglion. It tightens the tympanic membrane.

The *stapedius* arises from the interior of the pyramid. Its tendon emerges from an aperture on the summit of the pyramid and is inserted into the posterior aspect of the neck of the stapes. It is supplied by a branch of the facial nerve. It is the antagonistic muscle of the tensor tympani for it pulls the head of the stapes backwards and thus throws the anterior end of its base lateralwards towards the tympanic cavity.

The **Nerves of the Tympanic Cavity** should next be studied. The course of the *chorda tympani nerve* through the tympanic cavity should be noted. It enters the tympanic cavity through the iter chordæ posterius in the posterior wall near the upper end of the membrana tympani. Then it traverses the medial surface of the membrana tympani through which it shines lying between its fibrous layer and the mucous lining at the level of the upper end of the manubrium. It issues out of the tympanic cavity through the iter chordæ anterius (canal of Huguier) at the medial end of the petrotympanic fissure.

The *tympanic plexus* ramifies upon the promontory on the medial wall of the tympanic cavity. It is formed by the tympanic branch of the glossopharyngeal nerve which communicates with the superior and inferior carotico tympanic branches of the internal carotid plexus of the sympathetic. Its branchces supply the mucous lining of the cavity.

The **Arteries of the Tympanic Cavity** are :—(1) The ***anterior tympanic branch*** of the internal maxillary artery which enters the tympanic cavity through the petrotympanic fissure and

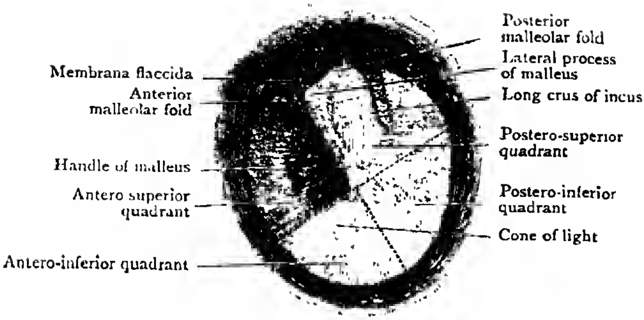


Fig. 118.—The tympanic membrane as seen during an otoscopic examination (Howden).

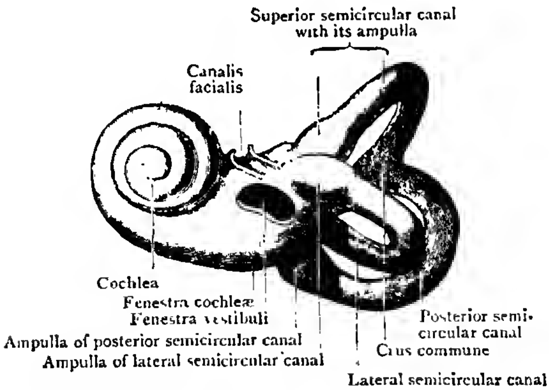


Fig. 119.—The osseous labyrinth (Howden).

To face P. 380

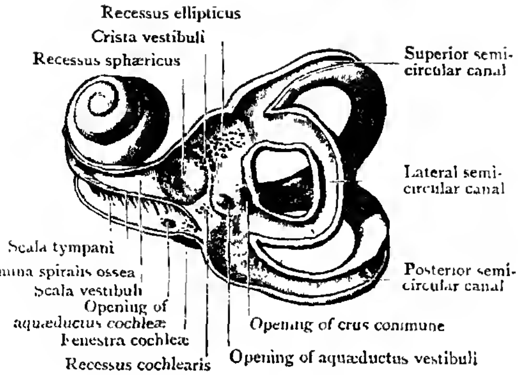


Fig. 120.—The interior of the osseous labyrinth (Howden).

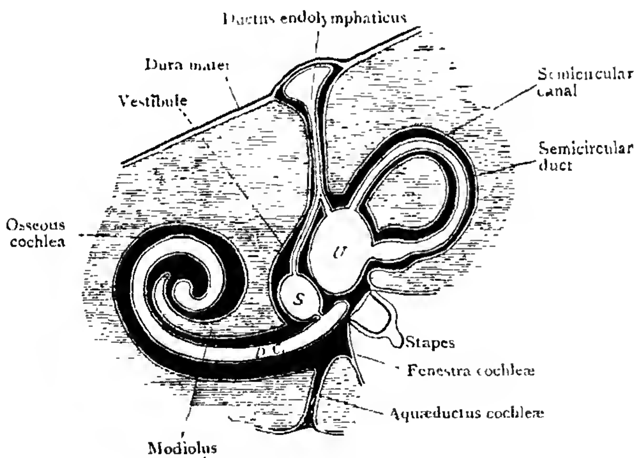


FIG. 121.—Diagram of the Osseous and Membranous Labyrinth. (Modified from Testut.)

U. Utricle. *S.* Saccule. *D C.* Ductus cochlearis.

supplies the tympanic membrane ; (2) the *stylomastoid branch of the posterior auricular artery* which passes through the stylomastoid foramen to enter the back part of the tympanic cavity and supplies the mastoid air cells and the tympanic antrum ; (3) the *petrosal branch of the middle meningeal artery* which enters through the hiatus of the facial canal ; (4) the *inferior tympanic branch of the ascending pharyngeal artery* which accompanies the tympanic branch of the glossopharyngeal nerve through the inferior tympanic canaliculus ; (5) the *tympanic branch of the internal carotid artery* which enters through the anterior or carotid wall of the tympanic cavity ; and (6) a *small branch of the artery of the pterygoid canal* which enters with the auditory tube. These six arteries have been traced from their origin to the points of their entrance into the temporal bone. They anastomose freely inside the tympanic cavity.

The **Mucous Membrane of the Tympanic Cavity** lines the ossicles, ligaments and muscles and is continuous with that of the pharynx through the auditory tube. It lines the medial surface of the membrana tympani and also the tympanic antrum and mastoid air sinuses.

Dissection. The facial nerve should now be exposed in the facial canal. Remove the auditory ossicles. Remove the lateral wall of the tympanic cavity with bone forceps. Then by a horizontal saw-cut remove a slice of bone immediately above the level of the roof of the internal acoustic meatus. Next with bone forceps remove the thin layer of bone still forming the roof of the meatus. The facial nerve is now exposed at its point of entrance into the facial canal. Open up the facial canal commencing from the bottom of the internal acoustic meatus. Trace the facial nerve lateralwards in the canal up to the hiatus canalis facialis (which also has to be opened up) ; then backwards along the medial wall of the tympanic cavity ; next follow it downwards along the posterior wall to its exit from the stylomastoid foramen. If the student can have the temporal bone softened in dilute acid solution the whole of the facial canal can be easily opened up by cutting with the knife. The lateral wall of the tympanic cavity need not be removed, but the upper part of the bony ring to which the tympanic membrane is attached should be bent laterally.

Facial Nerve in the Temporal Bone.—In the temporal bone the facial nerve presents four stages. The *first stage* is in the internal acoustic meatus where the facial nerve consisting of its

motor and sensory roots passes above and anterior to the acoustic nerve ; the sensory root lying between the motor root and the acoustic nerve ; the two roots join within the meatus. In the *second stage* the facial nerve trunk enters the facial canal at the bottom of the meatus ; in the facial canal the nerve at first runs lateralwards over the vestibule between the cochlea in front and the semicircular canals behind and presents a swelling called the *genicular ganglion.* In the *third stage*, the nerve bends backwards abruptly at the ganglion, passes along the upper part of the medial wall of the tympanic cavity and reaches the posterior wall of the middle ear. In the *fourth stage*, the nerve descends almost vertically to its point of exit from the stylomastoid foramen.

The *branches* of the facial nerve in the facial canal are : (1) The *greater superficial petrosal nerve* which arises from the genicular ganglion and passes through the hiatus of the facial canal. Its subsequent course has been described (p. 217). (2) The *communicating filament* to the lesser superficial petrosal nerve arises from the genicular ganglion. (3) The *external petrosal nerve* is a minute filament which arises from the genicular ganglion and joins the the sympathetic plexus around the middle meningeal artery. (4) The *nerve to the stapedius* arises from the facial nerve when it passes through the facial canal behind the pyramid. (5) The *communicating filament* to the auricular branch of the vagus arises below the origin of the nerve to the stapedius. (6) The *chorda tympani nerve* carries the sensory fibres of the facial nerve and arises a little above the termination of the parent trunk in the facial canal. Its course along the membrana tympani has been examined.

The **Acoustic Nerve** lies below and behind the facial nerve in the internal acoustic meatus. At the bottom of the meatus it divides into two divisions, the *cochlear* and the *vestibular.* Filaments from these enter the minute apertures in the lamina cribrosa for distribution to the different parts of the internal ear.

The bony labyrinth consists of the cochlea in front, the vestibule in the middle, and the semicircular canals behind. Locate the positions of these parts in the petrous portion of the bone and with a chisel define the bony labyrinth. Remove with the chisel the thin plate of bone covering the eminentia arcuata and define the semicircular canal lying underneath at right angles to the long axis of the petrous bone. Similarly remove a thin

plate of bone from the posterior surface of the petrous bone lateral to the internal acoustic meatus and define the posterior semicircular canal lying parallel to this surface. The lateral semicircular canal lies horizontally between the superior and posterior canals. Note that the facial canal as it passes lateralwards from the bottom of the internal acoustic meatus overlies the vestibule, and in front of the latter chamber is the cochlea coiled like the shell of a snail.

The **Internal Ear** or **Labyrinth** consists of two parts: (1) the osseous labyrinth being a series of cavities hollowed out of the petrous portion of the temporal bone, which intercommunicate with each other and are called the vestibule, semicircular canals and cochlea; and (2) the membranous labyrinth consisting of membranous channels contained within the osseous labyrinth.

The **Vestibule** is the central chamber of the bony labyrinth and is situated behind the cochlea and in front of the semicircular canals. It is ovoid in shape and measures about one sixth of an inch anteroposteriorly. On its *lateral wall* is seen the fenestra vestibuli which is closed in the recent state by the base of the stapes. Its *medial wall* corresponds to the bottom of the internal acoustic meatus and presents in front a circular depression, the *recessus sphericus*, which lodges the saccule and is perforated by minute apertures for the passage of filaments from the acoustic nerve to the saccule. Behind this circular depression is an oblique ridge called the *crista vestibuli*. The ridge encloses below a minute depression, the *fossa cochlearis*, which presents apertures for filaments of the acoustic nerve to supply the ductus cochlearis. At the back part of the medial wall is the opening of the *aquæductus vestibuli* which leads to the posterior surface of the petrous portion of the temporal bone. It lodges a diverticulum of the membranous labyrinth called the *ductus endolymphaticus*. On the *upper wall* or *roof* is an elliptical depression, called the *recessus ellipticus*, which lodges the utricle. The vestibule communicates behind with the three semicircular canals by five openings and in front by an oval opening with the scala vestibuli of the cochlea.

The **Bony Semicircular Canals** are three in number and named superior, posterior, and lateral. Each canal presents a dilatation at one end, called the *ampulla*, where it opens into the vestibule. The *superior semicircular canal* is vertically placed at right angles to the long axis of the petrous portion of the temporal bone. Its lateral end is ampullated and its medial end joins

with the upper end of the posterior semicircular canal forming the *crus commune.* The *posterior semicircular canal* is also vertically placed parallel to the posterior surface of the petrous portion of the temporal bone. Its upper end joins the medial end of the superior semicircular canal forming the crus commune. Its lower end is ampullated. The *lateral semicircular canal* is horizontal and placed between the superior and posterior semicircular canals. It projects into the medial wall of the tympanic antrum. Its ampullated end is close to the ampullated end of the superior semicircular canal ; its posterior end opens below the crus commune.

The **Cochlea** resembles somewhat the shell of a snail and is conical in shape. Its apex or *cupola* is directed forwards and lateralwards. Its *base* is directed backwards and medialwards towards the bottom of the internal acoustic meatus and is perforated by several minute apertures for the passage of filaments of the cochlear division of the acoustic nerve. It consists of a canal wound spirally for two turns and a half around a central pillar called the *modiolus*. This canal is partially subdivided into two passages by a thin lamina of bone, termed the *lamina spiralis,* which projects from the modiolus and follows the turns of the canal. The upper passage is called the *scala vestibuli* and the lower one, the *scala tympani*. The lamina spiralis leaves an opening at the cupola, called the *helicotrema*, through which the scala vestibuli and scala tympani communicate with each other. The modiolus is conical in shape with its base at the internal acoustic meatus and apex at the cupola. It is perforated by minute canals for the passage of cochlear nerve filaments. One of these canals is called the *longitudinal canal of the modiolus* and traverses it from base to apex.

The **Membranous Labyrinth** is situated within the bony labyrinth. The *membranous semicircular ducts* correspond exactly in contour to the bony canals within which they are contained. They are separated from the bony canals by perilymph except at one place where they are attached. Within the bony vestibule there are two membranous sacs called the utricle and the saccule. The *utricle* lies behind and into it the membranous semicircular ducts open. The *saccule* lies in front and communicates with the membranous cochlea by a canal called the *canalis reuniens*. The utricle and the saccule indirectly communicate with each other through the ductus endolymphaticus to which each is joined by a narrow duct. The membranous cochlea is

called the *ductus cochlearis* (scala media). It is formed by two membranes which are attached medially to the free margin of the lamina spiralis and laterally they diverge to become attached to the lateral wall of the bony cochlea. The upper membrane is called the *membrana vestibuli* (membrane of Reissner) and the lower one, *membrana basilaris*. Thus the separation between the scala vestibuli and scala tympani is complete. *The ductus cochlearis is closed towards the apex* of the cochlea and at its base communicates with the saccule by the ductus reuniens. The scala tympani communicates with the tympanic cavity through the fenestra cochlearis which is closed in the recent state by the secondary tympanic membrane.

THE EYEBALL

Before the student begins with the actual dissection of the eyeball he should obtain a general idea of its structures from a model in the museum. As the eyeball is scarcely obtained in a fresh condition in the dissecting-room the student should procure half a dozen eyeballs of the ox. On account of their larger size they are better than eyeballs of the sheep for purposes of dissection. He should complete his examination of the organ by dissecting a fresh human eyeball which can be procured from the post mortem room. Sections of the eyeball can be satisfactorily made when the specimens have been hardened for some days in a ten per cent. solution of formalin.

The **Eyeball** lies in the orbital cavity embedded in a mass of fat and enveloped by the fascia bulbi. It is composed of segments of two spheres; the posterior or scleral segment forms about five sixths of the eyeball and the anterior or corneal segment forms about one sixth of the globe. The terms *anterior* and *posterior poles* as applied to the eyeball denote the central points of its anterior and posterior curvatures and a line which joins these two poles is called the *optic axis*. An imaginary line drawn midway between the two poles and encircling the eyeball is called the *equator*.

The eyeball consists of three investing tunics and three refracting media. The three tunics are : (1) an outermost fibrous tunic formed by the sclera behind and the cornea in front; (2) an intermediate vascular tunic formed from behind forwards by the chorioid, ciliary body, and iris ; and (3) an innermost nervous tunic formed by the retina. The three refracting media are :

(1) the aqueous humour in front, (2) the crystalline lens in the middle, and (3) the vitreous body at the back part of the interior of the eyeball.

Dissection. The student should remove with scissors all the soft parts from the surface of the sclera—the conjunctiva, fascia bulbi, remains of the ocular muscles and fat. He will notice numerous small apertures for the ciliary arteries and nerves around the lamina cribrosa. The venæ vorticosæ, four or five in number, will be seen to pierce the sclera a little behind the equator of the eyeball.

The **Sclera** (sclerotic) is a dense fibrous membrane which occupies the posterior five-sixths of the eyeball and maintains its shape. Its external surface is white and lies in contact with the fascia bulbi. It is pierced by the optic nerve about 3 mm. to the medial side of the posterior pole of the eyeball. Here it assumes the appearance of a cribriform lamina, called the *lamina cribrosa,* which presents minute orifices for the passage of the filaments of the optic nerve. One of the orifices occupies the centre of the lamina and transmits the central artery and vein of the retina. Around the lamina are many minute apertures for the passage of the posterior ciliary arteries and ciliary nerves. Almost midway between the entrance of the optic nerve and the sclero-corneal junction are four or five openings for the exit of veins called the *venæ vorticosæ.* The front part of the sclera is covered by conjunctiva and near its junction with the cornea (*sclero-corneal junction*) it is pierced by the anterior ciliary arteries. Close to the sclerocorneal junction there exists in the substance of the sclera a circular canal called the *sinus venosus scleræ* (canal of Schlemm). If a sagittal section is made through an eyeball this sinus is seen as a minute opening at the cut margin of the sclera near the sclerocorneal junction.

Dissection. Divide the sclera along the equator of the eyeball with the knife taking care that the chorioid tunic lying next to it is not injured. First make an opening in the sclera and then introduce a director through the opening to detach the sclera from the chorioid. Then cut along the equator of the eyeball taking the director as the guide. The sclera is thus divided into an anterior and a posterior segment. Raise the two segments from the subjacent chorioid. Reflect the anterior segment forwards; some difficulty will be felt near its junction with cornea where the ciliary muscle is attached to its deep sur-

face. This attachment can be easily broken with the handle of the scalpel: note that the aqueous humour escapes when this is done. The posterior segment is to be separated by dividing the optic nerve at the point of its entrance into the sclera. When the two segments of the outer tunic are reflected in this manner an uninterrupted view of the whole of the intermediate tunic is presented for examination. Place the eyeball thus denuded of its external tunic in a tray containing water.

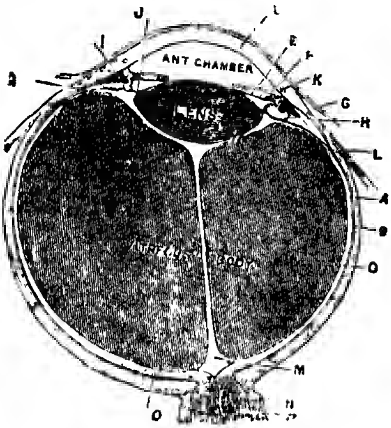
Note that the inner surface of the sclera is smooth. It has a brown colour and presents grooves for the lodgement of ciliary vessels and nerves. It is loosely attached to the chorioid for an extensive lymph space, called the *perichorioidal lymph space*, separates the inner surface of the sclera from the outer surface of the chorioid and this lymph space is traversed by cellular tissue called the *lamina suprachorioidea* (lamina fusca). Note that close to the entrance of the optic nerve the sclera is firmly adherent to the chorioid. Note also that the sclera is much thicker behind than in front.

The **Cornea** forms the anterior sixth of the external tunic of the eyeball. It is transparent and almost circular and its curvature varies in different individuals. Posteriorly its margin is overlapped by the margin of the sclera. Its anterior surface is convex and covered by conjunctiva which is closely adherent to it. Its posterior surface is concave and covered by a very elastic stratum called the *posterior elastic lamina*. At the sclero-corneal junction the posterior elastic lamina breaks up into fibres forming a meshwork and enclosing a large number of minute spaces between them called the *spatia anguli iridis* (spaces of Fontana). Some of these fibres are prolonged on to the surface of the iris forming the *ligamentum pectinatum iridis*. Others are prolonged backwards to the sclera and chorioid.

The **Chorioid** is a vascular, darkly-pigmented membrane occupying the posterior five-sixths of the eyeball and is continuous in front with the ciliary body and iris. It is thicker behind than in front. It is pierced behind by the optic nerve. Its outer surface is loosely attached to the sclera by the lamina suprachorioidea. The ciliary nerves run from behind forwards along this surface and look like fine white threads. The ciliary veins are seen on this surface to converge to form four or five venous trunks which are situated along the equator of the eyeball at equal distances from each other. These converging veins are called the *venæ vorticosæ*. Structurally the chorioid practically

consists of two layers, an outer and an inner. The outer layer is called the *lamina vasculosa* and is formed by the branches

Fig. 121.—Horizontal section of the bulb of the eye (Cunningham).



A. Sclera.
B. Chorioid.
C. Retina.
D. Cornea.
E. Iris.
F. Posterior chamber.
G. Conjunctiva.
H. Ciliary process.
I. Ciliary muscle.
J Suspensory ligament of lens.
K. Sinus venosus scleræ.
L. Ora serrata.
M. Hyaloid canal.
N. Optic nerve.
O Macula lutea.
P. Nerve sheath (of dura mater).

of the posterior ciliary arteries and the venæ vorticosæ. The inner layer is called the *lamina choriocapillaris* and is formed by the capillaries of the blood vessels of the outer layer. The inner surface of the chorioid is adherent to the pigmented layer of the retina. In the eyeball of the ox which is being dissected a bright greenish colour is seen on the back part of the chorioid when viewed from the front. This is due to the presence of another layer in the chorioid called the *tapetum*. This layer is absent in the eyeball of man.

The **Ciliary Body** (Fig. 123) consists of the orbiculus ciliaris, the ciliary processes, and the ciliary muscle.

The *orbiculus ciliaris* forms a zone of about one sixth of an inch in width. It is continuous with the chorioid, lying immediately in front of it. It presents numerous ridges arranged radially.

Dissection. Make a coronal section through an eyeball at the equator and remove the vitreous body and the lens. The ciliary processes will be seen to radiate backwards from the circumference of the lens. Put the specimen in a tray filled with water.

The *ciliary processes* form a circle of elongated ridges, about seventy in number. There are also small ridges which occupy the spaces between the large ridges. These ridges are formed

by the folding inwards of the layers of the chorioid and they fit into the plications of the suspensory ligament of the lens. They are attached peripherally to the finer ridges of the orbiculus ciliaris and are therefore continuous with the chorioid. Their opposite ends are directed towards the circumference of the lens and are continuous with the periphery of the iris.

The *ciliary muscle* consists of unstriped muscle fibres. It is a circular band about one-eighth of an inch in width, situated in front of the chorioid surrounding the circumference of the iris. It consists of two sets of fibres, meridional and circular, which arise from the sclera near the sclerocorneal junction. The meridional fibres pass backwards to be inserted into the orbiculus ciliaris and ciliary processes. The circular fibres form a ring which is inserted around the circumference of the iris. The ciliary muscle is supplied by the ciliary nerves. *Action.*—It is the muscle of accomodation -it adjusts the eye for vision at near distances. When the meridional fibres contract they pull the chorioid forwards causing relaxation of the suspensory ligament and hence the anterior surface of the lens becomes more convex by virtue of its elasticity.

The **Iris** is a thin muscular curtain situated in front of the lens and behind the cornea. It is circular in shape and its colour varies in different individuals. It is pierced in the centre by a circular aperture in man called the *pupil.* In the ox the pupil is a transverse slit. Two sets of involuntary muscle fibres are found in the iris : (1) the circular fibres which form a band round the pupil called the *sphincter pupillæ* ; (2) the radiating fibres which extend from the sphincter to the circumference of the iris in a radiating manner and constitute the *dilator pupillæ.* The sphincter pupillæ is supplied by the oculomotor nerve (parasympathetic fibres). The dilator pupillæ is supplied by sympathetic fibres. The student should note here the antagonistic functions of the parasympathetic and sympathetic fibres referred to on page 96.

The **Ciliary Nerves** pierce the sclera around the optic nerve and proceed forwards between the sclera and chorioid as minute white threads till they reach the ciliary zone. Here they form a plexus around the periphery of the iris and supply the ciliary muscle, iris, and cornea. The long ciliary nerves are the branches of the nasociliary nerve and are purely sensory nerves ; while the short ciliary nerves derived from the ciliary ganglion contain parasympathetic fibres (from the motor oculi), sensory fibres

(from the nasociliary) and sympathetic fibres (from the cavernous plexus).

Ciliary Arteries.—(1) The two *long posterior ciliary arteries* pierce the sclera a little in front of the optic nerve and pass, one on either side, between the sclera and chorioid. Reaching the ciliary zone each divides into an ascending and a descending branch. These branches communicate with each other and form an arterial circle around the periphery of the iris, called the *circulus iridis major* This circle is joined by the anterior ciliary arteries. From the arterial circle branches proceed towards the pupillary margin and these form a second arterial circle called the *circulus iridis minor.* (2) The *short posterior ciliary arteries* pierce the sclera around the optic nerve and are distributed to the chorioid. (3) The *anterior ciliary arteries* (p. 339) pierce the sclera close to the sclerocorneal junction and join the circulus iridis major.

Dissection. The student should now proceed to expose the retina fully. Take the specimen which has been divided sagittally and remove from it the lens and the vitreous body. This exposes the inner surface of the retina. From the specimen in which the vascular tunic has been exposed, remove the chorioid, the ciliary zone, and the iris bit by bit. This will expose the outer surface of the retina.

The **Retina** is the innermost tunic of the eyeball and consists of an outer pigmented layer and an inner nervous layer. Its outer surface is attached to the chorioid by its pigmentary layer. Its inner surface lies in contact by its nervous layer with the hyaloid membrane of the vitreous body to which however it is not attached except at the optic entrance. Anteriorly the retina becomes thinner and near the ciliary body presents an irregular wavy margin called the *ora serrata.* Beyond the ora serrata the nervous elements of the retina cease and its outer pigmentary layer covered by a layer of epithelium is continued forwards over the ciliary processes and the iris forming the *pars ciliaris retinæ* and *pars iridica retinæ* respectively. Posteriorly the retina is firmly adherent at the entrance of the optic nerve. At the optic entrance the retina presents the appearance of a circular, whitish disc, *optic disc*, with a slightly raised margin called the *papilla of the optic nerve.* The surface of the disc presents a slight depression called the *excavation of the optic nerve.* At the optic papilla, the optic nerve expands—radiates out in such a manner as to form the nervous layer of the retina. The papilla

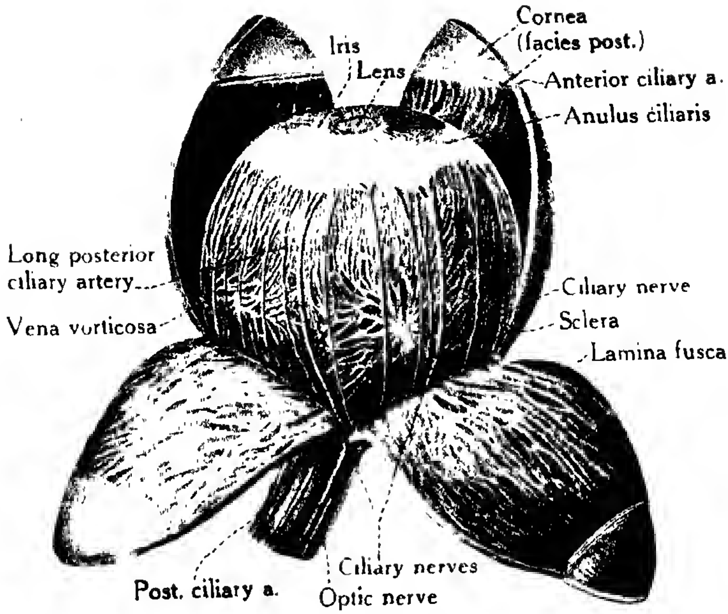


Fig. 123.—Dissection of the eyeball, showing the chorioid, iris, ciliary vessels and nerves (Sobotta).

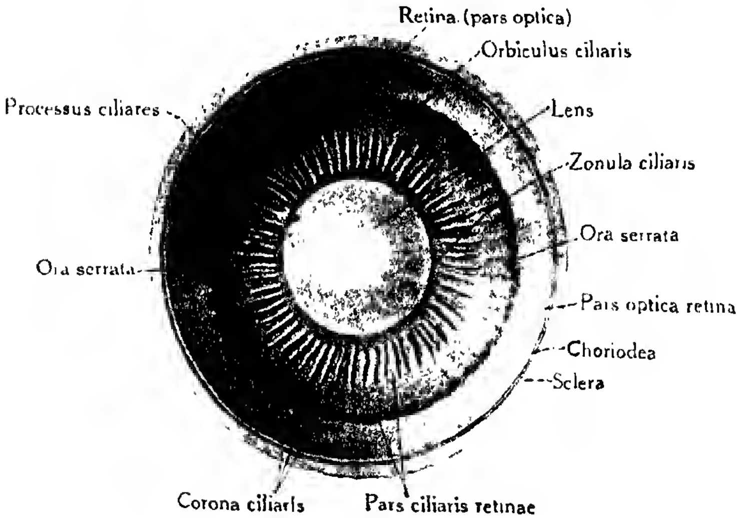


Fig. 124.—Structures seen in the interior of the anterior half of the eyeball (Sobotta).

To face p. 390.

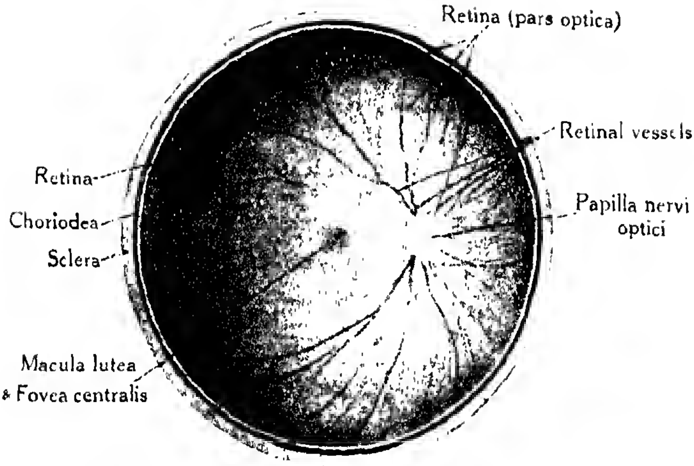


Fig. 125.—Structures seen in the interior of the posterior half of the eyeball (Sobotta).

is pierced in the centre by the central artery and vein of the retina. Exactly in the centre of the retina and directly in the optic axis and about one eighth of an inch to the lateral side of the optic entrance, there is a small oval yellowish spot called the *macula lutea* which has a central depression called the *fovea centralis*. The visual sense is most perfect in the macula lutea. The student will not find macula lutea in the eyeball of the ox. The ramifications of the branches of the *arteria centralis retinæ* can be studied in a fresh eyeball—these do not anastomse with each other but reach as far as the ora serrata. The *retinal veins* reach the optic papilla from all directions and ultimately unite into one trunk which passes through the substance of the optic nerve.

The **Refracting Media** are three in number, (1) the aqueous humour, (2) the vitreous body, and (3) the crystalline lens.

The *aqueous humour* occupies the space known as the anterior and posterior chambers. It is transparent and composed of water, holding in solution a very small amount of sodium chloride.The *anterior chamber* is bounded in front by the cornea behind by the iris and the central part of the lens, and laterally by the ligamentum pectinatum iridis, where a recess is seen called the *iridial angle* (filtration angle) which leads into the spatia anguli iridis. The *posterior chamber* is bounded in front by the iris, behind by the anterior surface of the lens with its suspensory ligament, and laterally by the ciliary processes. The two chambers communicate through the pupil. The aqueous humour is secreted by the ciliary processes and passes through the iridial angle of the anterior chamber into the anterior ciliary veins.

Dissection. In order to expose the vitreous body and the lens take another eyeball, divide its tunics circularly at the equator and draw the anterior and posterior segments apart. The vitreous body with the lens are expelled in one mass.

The **Vitreous Body** is a transparent jelly-like mass and is composed of water holding in solution a very small quantity of salts and protein. It is enclosed in a delicate, transparent membrane called the *hyaloid membrane*. It fills up the posterior four-fifths of the interior of the eyeball. It presents in front a concavity, called the *hyaloid fossa*, into which the lens is received. A minute canal, called the *hyaloid canal*, runs through the substance of the vitreous body from the region of the optic papilla to the posterior surface of the lens. This canal contains lymph

and its wall is formed by a prolongation of the hyaloid membrane. In the embyro it transmits the hyaloid artery to the posterior surface of the lens. Arteries do not enter the vitreous body; its nutrition is carried on by lymph.

The *hyaloid membrane* encloses the vitreous body. In front of the ora serrata it is distinctly thick and called the *zonula ciliaris* (zonule of Zinn). The zonula presents a series of alternating elevations and depressions arranged radially. The depressions receive the ciliary processes while the elevations extend into the intervals between these processes. As it approaches the lens it divides into two layers: (1) a thin lamina which lines the hyaloid fossa behind the lens, and (2) a thick layer, called the *suspensory ligament of the lens*, which passes over the ciliary body and becomes attached to the capsule of the lens in front of its equator or circumference. But some fibres of the suspensory ligament are also attached to the equator of the lens. Behind the suspensory ligament and in front of the posterior layer of the zonula ciliaris there is a circular lymph space, called the *spatia zonularia* (canal of Petit) which surrounds the circumference of the lens. This space can be inflated by a fine pointed blow pipe.

The **Crystalline Lens** is a biconvex, transparent body placed in front of the vitreous body and behind the iris. It is enclosed within a thin transparent membrane called the *capsule of the lens*. It rests in the hyaloid fossa and is retained in that position by the suspensory ligament. Its anterior surface is less convex than the posterior. Its circumference or equator projects into the spatia zonularia.

Structure of the lens.—The outer portion of the lens is softer and is called the cortex, whilst the central portion is firmer and is called the nucleus of the lens. From the surface of the hardened lens concentric laminæ can be peeled off like the coats of the onion. These laminæ are the lens fibres formed by the elongation of the cells of the lens.

THE ENCEPHALON OR BRAIN

Before commecing the study of the membranes and blood vessels of the brain the student should form an idea of the general appearances presented by the organ and the arrangement of its main parts. For this he should refer to a model of the brain

or if available to another brain from which the meninges and blood vessels have been removed. He should note the ovoid hemispheres of the cerebrum which on account of their large bulk cover from above the other parts of the organ. Broadly speaking each hemisphere is subdivided into four lobes, viz., the frontal lobe in front, the parietal lobe in the middle, the occipital lobe behind, and the temporal lobe below. The position of the central sulcus separating the frontal from the parietal lobe, of the parietooccipital fissure separating the parietal from the occipital lobe, and of the lateral sulcus separating the frontal and parietal lobes above from the temporal lobe below should be noted. The fifth lobe or insula lies concealed in the lateral sulcus and has to be seen by drawing the margins of the sulcus apart. The cerebral peduncles emerge from the under surface of the cerebral hemispheres. The hind brain consists of the cerebellum lying behind, and the pons and medulla oblongata in front. The cerebellum consists of two lateral parts, the hemispheres, and a median part called the vermis; its surface presents innumerable parallel and curved sulci which give it a laminated appearance. The pons connects the cerebrum above, the medulla oblongata below, and the cerebellum behind. The medulla oblongata begins from the lower border of the pons and becomes continuous with the medulla spinalis. The surfaces of the cerebral hemispheres are marked by elevations called gyri, and indentations called fissures or sulci. The longitudinal fissure incompletely separates the two hemispheres from each other. At the bottom of this fissure a great transverse commissure is seen connecting the two hemispheres. This is called the corpus callosum. It presents anteriorly a curved end called the genu and posteriorly a thick end called the splenium.

Meninges of the Brain.—These are three in number, the dura mater, arachnoid and pia mater. The *dura mater* has been described (p. 204). The *arachnoid* is an exceedingly thin membrane covering the whole of the brain. It is placed over the pia mater which it closely invests, except over the base of the brain—over this region the arachnoid can be properly examined because here it is not only thick but is also separated from the subjacent pia mater by a considerable interval. Unlike the pia mater it does not dip into the fissures and sulci of the brain (except into the longitudinal fissure) but bridges over them. It is separated from the dura mater by a capillary space called the *subdural space* which contains fluid of the nature

of lymph. It is separated from the subjacent pia mater by an interval, called the *subarachnoid cavity*, which contains cerebrospinal fluid and is transversed by trabeculæ of connective tissue passing from the arachnoid to the pia mater. The arachnoidean granulations which are processes of this trabecular tissue have been examined (p. 204). The subarachnoid cavity of the brain is continuous with the subarachnoid cavity of the medulla spinalis and communicates with the ventricles of the brain. Over the lateral surface of the hemispheres the subarachnoid cavity is insignificant but in certain situations at the base of the brain the arachnoid is separated from the pia mater by deep and wide intervals called subarachnoid cisternæ.

Subarachnoid Cisternæ.—These are:—(1) The *cisterna cerebellomedullaris* (cisterna magna) which is formed by the arachnoid bridging over the space between the medulla oblongata and the back part of the under surface of the cerebellum. (2) The *cisterna pontis* is seen on the ventral aspect on the pons where the arachnoid covers the basilar artery. (3) The *cisterna interpeduncularis* (cisterna basalis) lies in front of the pons where the arachnoid extends from the temporal lobe of one side to that of the other side; it contains the arteries of the circulus arteriosus. (4) The *cisterna chiasmatis* lies in front of the optic chiasma and contains the anterior cerebral arteries. (5) The *cisterna fossæ cerebri lateralis* is formed over the lateral fissures of the brain by the arachnoid bridging over the fissure between the temporal lobe, and the frontal and parietal lobes. (6) The *cisterna venæ magnæ cerebri*, is formed by the arachnoid bridging over the gap between the posterior end of the corpus callosum and the superior surface of the cerebellum; it contains the great cerebral vein.

The *pia mater* is the vascular membrane of the brain. In it the blood vessels ramify and from its deep surface minute arterial twigs enter the substance of the brain. It gives off sheaths to these numerous minute vessels as they enter the brain substance. It also gives off sheaths to the cerebral nerves as they pass out. It dips into the fissures and sulci of the cerebrum and cerebellum. On the surface of the cerebellum it is thinner and less vascular. It is prolonged into the interior of the brain forming the tela chorioidea of the third ventricle and the chorioid plexuses of the lateral and third ventricles. Over the lower part of the roof of the fourth ventricle it forms the tela chorioidea and chorioid plexuses of the fourth ventricle. There are three openings in the pia mater through which the subarachnoid

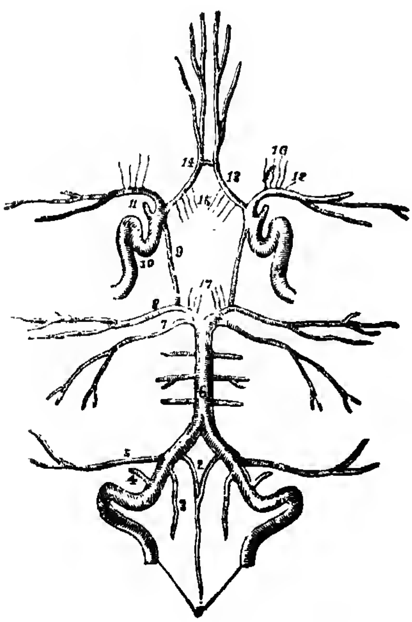
cavity communicates with the ventricles of the brain. One is called the *foramen of Majendie* and is situated in the middle line over the inferior angle of the roof of the fourth ventricle. The other two apertures are laterally placed over the ends of the lateral recesses of the fourth ventricle. Two other apertures are said to be present in the pia mater at the apices of the inferior cornua of the lateral ventricles.

The dissector should now study the arteries of the brain.

Arteries of the Brain.—These are derived from the two internal carotid and the two vertebral arteries, the branches of which form a remarkable anastomosis at the base of the brain called the circulus arteriosus.

The **Internal Carotid Artery** has been divided where it pierced the dura mater on the medial side of the anterior clinoid process (p. 215). It passes to the medial extremity of the lateral cerebral fissure where it divides into the anterior and middle cerebral arteries. The branches given off from the cerebral portion of the artery are: (1) the anterior cerebral, (2) the middle cerebral, (3) the posterior communicating, and (4) the anterior chorioid.

Fig. 126.—Arteries of the brain and the arterial circle at the base of the brain (Wilson).



1. Vertebral arteries.
2. Anterior spinal branches uniting to form a single vessel.
3. Posterior spinal artery.
4. Meningeal branch of vertebral artery.
5. Posterior inferior cerebellar artery.
6. Basilar artery giving off pontine branches.
7. Superior cerebellar artery.
8. Posterior cerebral artery.
9. Posterior communicating branch of internal carotid artery.
10. Internal carotid artery.
11. Ophthalmic artery.
12. Middle cerebral artery.
13. Anterior cerebral artery.
14. Anterior communicating artery.
15. Antero-medial ganglionic branches of anterior cerebral artery.
16. Antero-lateral ganglionic branches of middle cerebral artery.
17. Postero-medial ganglionic branches of posterior cerebral artery.

The **Anterior Cerebral Artery** runs forwards and medialwards above the optic nerve to the anterior extremity of the longitudinal fissure. Here it lies side by side with the artery of the opposite side and the two vessels are connected by a short transverse branch called the *anterior communicating artery*. Then it proceeds forwards along the medial aspect of the frontal lobe and curving round the genu of the corpus callosum is continued backwards over the upper surface of the corpus callosum towards the splenium where it anastomoses with the posterior cerebral artery. The *branches* given off from the anterior cerebral artery are :—(1) The *antero-medial ganglionic branches* which are small twigs. They pass upwards, pierce an area of grey substance, called the anterior perforated substance, and supply the anterior end of the caudate mucleus, the rostrum of the corpus callosum and the septum pellucidum. (2) The *inferior frontal branches*, two or three in number, supply the medial part of the orbital surface of the frontal lobe and the olfactory tract and bulb. (3) The *anterior frontal branches* supply the anterior part of the medial surface and upper part of the lateral surface of the frontal lobe. (4) The *middle frontal branches* supply the medial surface of the frontal lobe behind the preceding branches. Its terminal twigs pass to the adjacent part of the lateral surface of the brain. (5) The *posterior frontal branches* supply the medial aspect of the brain in front of the parietooccipital fissure ; the terminal twigs supply the adjacent part of the lateral surface of the parietal lobe.

The **Middle Cerebral Artery** proceeds along the lateral cerebral fissure at first lateralwards and then backwards and divides into several terminal branches on the insula. Its *branches* are:—(1) The *antero-lateral ganglionic branches* which are numerous twigs. They pass upwards through the anterior perforated substance and supply certain grey masses called basal ganglia and the internal and external capsules. (2) The *inferior lateral frontal branches* supply the lateral part of the orbital surface and the lower part of the lateral surface of the frontal lobe. (3) The *ascending frontal branch* ramifies over the anterior central gyrus lying in front of the central sulcus. (4) The *ascending parietal branch* supplies the posterior central gyrus lying behind the central sulcus. (5) The *parieto-temporal branch* supplies the inferior part of the parietal lobe and the posterior part of the temporal lobe. (6) The *temporal branches* curve downwards to supply the front part of the lateral surface of the temporal lobe.

The **Posterior Communicating Artery** is a slender branch which proceeds directly backwards to join the posterior cerebral artery. From it several minute posteromedial ganglionic branches are given off.

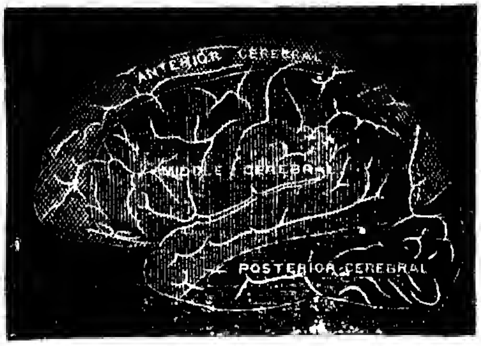


Fig. 127.—Diagram showing the distribution of cortical branches of cerebral arteries on the lateral surface of the brain.

The **Anterior Chorioidal Artery** issues from the internal carotid near the posterior communicating branch and passes backwards and lateralwards and enters the inferior cornu of the lateral ventricle to supply the chorioid plexus.

The **Vertebral Artery** enters the cranial cavity through the foramen magnum and proceeds along the side of the medulla oblongata gradually inclining medialwards to gain the anterior aspect of the medulla oblongata. At the lower border of the pons it unites with its fellow of the opposite side to form the basilar artery. Within the cranium it gives off the following *branches* :—(1) *Meningeal branch* which supplies the dura mater in the posterior cranial fossa. (2) The *posterior spinal artery* arises from the vertebral at the side of the medulla oblongata and passes downwards into the vertebral canal. Its course over the medulla spinalis has been mentioned (p. 240). (3) The *posterior inferior cerebellar artery* is the largest branch of the vertebral. It proceeds backwards along the side of the medulla oblongata to the under surface of the cerebellum and divides into two branches, a medial and a lateral. The medial branch runs backwards to the notch between the posterior ends of the cerebellar hemispheres. The lateral branch supplies the back part of the inferior surface of the cerebellar hemisphere as far as its lateral border. (4) The *anterior spinal artery* arises close to the lower border of

the pons, passes downwards and medialwards on the anterior surface of the medulla oblongata and unites with its fellow of the opposite side at the level of the foramen magnum. The single trunk thus formed descends along the antero-median fissure of the medulla spinalis (p. 247). (5) The *medullary branches* are minute twigs which enter the substance of the medulla oblongata.

The **Basilar Artery** is a short vessel which extends from the lower to the upper border of the pons and is formed by the union of the two vertebral arteries. It runs along the median groove on the ventral surface of the pons and terminates by dividing into the two posterior cerebral arteries. It gives off the following branches on each side :—(1) The *pontine branches*. These are many minute twigs which run lateralwards and supply the pons. (2) The *internal auditory artery* is a long slender branch ; it accompanies the acoustic nerve to the internal acoustic meatus and supplies the internal ear. (3) The *anterior inferior cerebellar artery* supplies the front part of the inferior surface of the cerebellum. (4) The *superior cerebellar artery* arises from the basilar artery near its termination. It winds round the cerebral peduncle and reaches the superior surface of the cerebellum which it supplies. (5) The *posterior cerebral artery*.

The **Posterior Cerebral Artery** runs lateralwards being separated from the superior cerebellar artery by the oculomotor nerve and is soon joined by the posterior communicating artery. Then it passes backwards and, winding round the peduncle of the cerebrum, reaches the under surface of the occipital lobe close to the splenium. The *branches* of the posterior cerebral

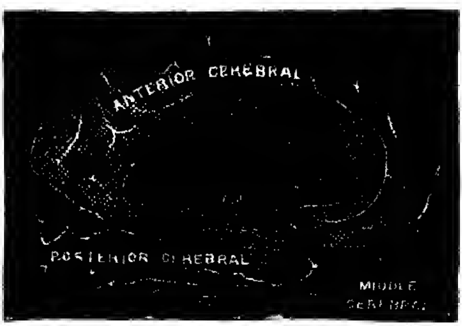


Fig. 128.—Diagram showing the distribution of cortical branches of cerebral arteries on the medial surface of the brain.

artery are :—(1) The *postero-medial ganglionic branches* which are minute twigs. They arise near the origin of the parent trunk and proceed upwards. Piercing a grey area, called the posterior perforated substance, they supply the thalamus. (2) The *posterior chorioidal artery* passes forwards beneath the splenium and enters the tela chorioidea of the third ventricle and the chorioid plexus of the lateral ventricle. (3) The *posterolateral ganglionic branches* are minute twigs which arise on the lateral side of the cerebral peduncle. They pass upwards to supply the thalamus. (4) The anterior and posterior *temporal branches* pass lateralwards to supply the lower surface of the temporal lobe. (5) The *calcarine branch* runs along the calcarine fissure and supplies the medial aspect of the occipital lobe. (6) The *parieto-occipital artery* runs upwards along the parieto-occipital fissure and supplies the gyri in front and behind the fissure. Its terminal branches supply the lateral surface of the occipital lobe.

Circulus Arteriosus (circle of Willis).—This important arterial anastomosis is situated at the base of the brain in the sub-arachnoid cavity above the pons. It is formed *in front* by the anterior cerebral arteries connected together by the anterior communicating artery ; *laterally* by the posterior communicating arteries, each of which connects the internal carotid artery (of the same side) in front and the posteroir cerebral artery behind ; *behind* by the two posterior cerebral arteries. On account of a complete anastomosis between the cerebral vessels in the circulus arteriosus, a free circulation of blood through the brain goes on at all times even if a large vessel on the side of the neck be obstructed.

The student has noticed that two systems of arterial branches supply the brain. (1) The *cortical system* of branches supply the surfaces of the different lobes of the brain and send minute twigs penetrating for some depth into the interior to supply the subjacent brain substance. These vessels anastomose to some extent with each other. (2) The *ganglionic system* of branches penetrate the substance of the brain to supply the basal ganglia. These branches do not anastomose with each other and hence are called terminal arteries.

Veins of the Brain.—The cerebral veins all terminate in the sinuses of the dura mater. They are divisible into two groups, external and internal. The former drain from the outer surface and the latter from the inner surface of the cerebrum. The

external cerebral veins are (1) superior, (2) middle, (3) inferior and (4) basal. The *superior cerebral veins* are six to twelve in number. They drain the venous blood from the medial surface and from the upper part of the lateral surface of the cerebral hemisphere and open into the superior sagittal sinus (p. 205). The anterior veins of this group open at right angles to the sinus and the posterior ones open obliquely forwards into the sinus against the current of blood in it. The *middle cerebral vein* receives venous blood from the lower part of the lateral surface of the cerebral hemisphere and courses along the lateral fissure from behind forwards to terminate in the cavernous sinus. It communicates with one of the superior cerebral veins by means of a venous channel, called the *great anastomotic vein*, and thus indirectly communicates with the sagittal sinus. Behind it also communicates with the transverse sinus by a vein, called the *posterior anastomotic vein*, which runs over the temporal lobe. The *inferior cerebral veins* are of small size. Those from the orbital surface of the frontal lobe open either into the anterior cerebral vein or into the middle cerebral vein. Those from the temporal lobe open into the basal vein or into the superior petrosal sinus or the transverse sinus. The *basal vein* is formed by the union of the anterior cerebral vein and deep middle cerebral vein at the anterior perforated substance. It is joined by an internal vein, viz., the *inferior striate vein*, which emerges from the anterior perforated substance. The basal vein passes backwards round the cerebral peduncle and opens into the internal cerebral vein. The *anterior cerebral vein* receives venous blood from the medial surface of the cerebral hemisphere. It accompanies the anterior cerebral artery and proceeds to the anterior perforated substance where it opens into the basal vein. The *deep middle cerebral vein* drains venous blood from the insula. It courses along the lateral fissure and opens into the basal vein at the anterior perforated substance.

Internal Group of Cerebral Veins.—The *great cerebral vein* (vena magna Galeni) is the large vein which drains venous blood from the interior of the cerebrum. Its formation by the union of the two internal cerebral veins beneath the corpus callosum between the two layers of the tela chorioidea of the third ventricle will be seen at a later stage of dissection. It issues beneath the posterior end of the corpus callosum and opens into the anterior end of the straight sinus. Its torn end beneath the splenium can now be seen. The *internal cerebral veins* are two in

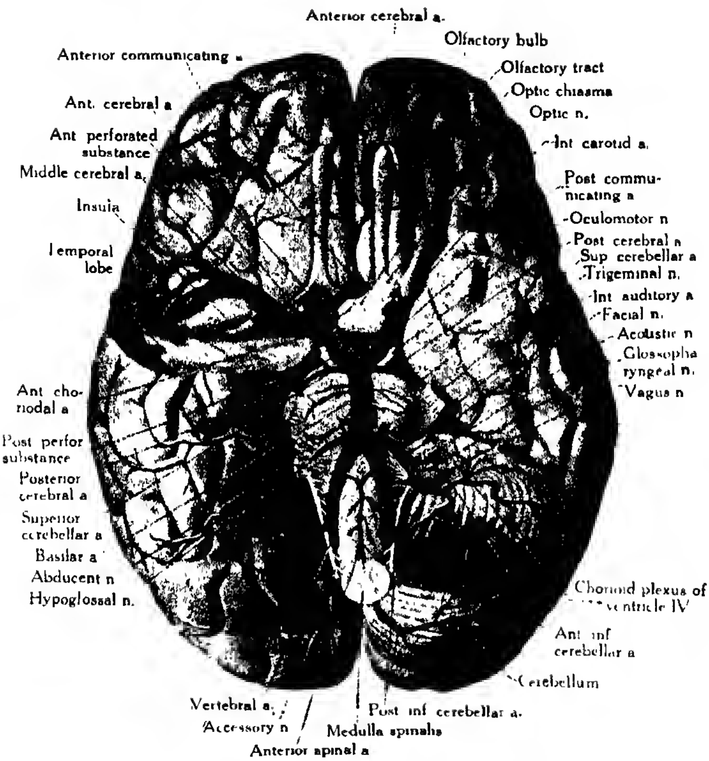


Fig. 129.—The arteries at the base of the brain (Sobotta).

To face P. 400

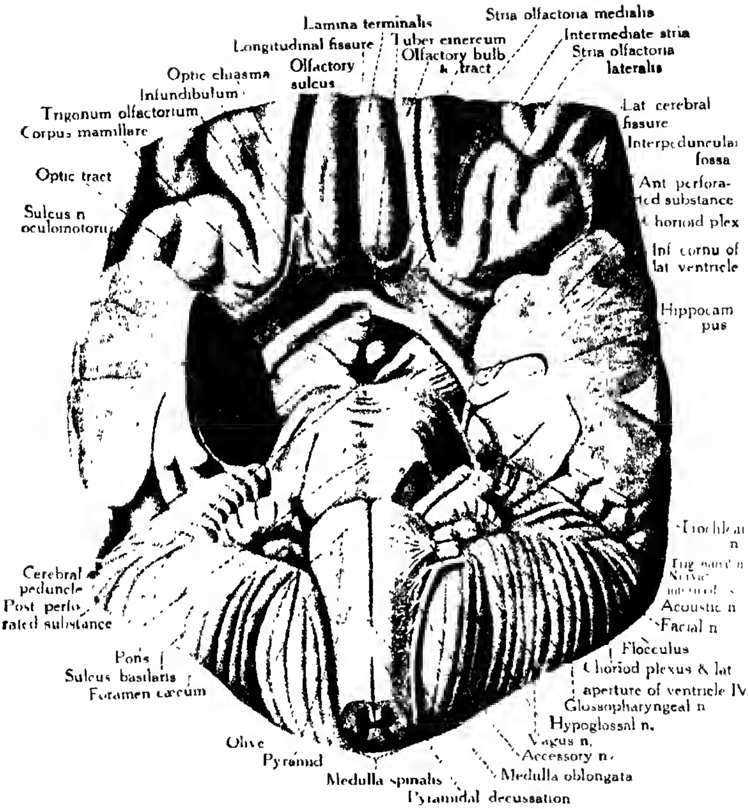


Fig. 130.—The Base of the Brain (Sobotta).

number ; each is formed by the union of the terminal and chorioid veins and passes backwards between the two layers of the tela chorioidea of the third ventricle to meet its fellow of the opposite side forming the great cerebral vein. These will be examined later on.

The *cerebellar veins* may be grouped into two sets, the superior and inferior. The *superior cerebellar veins* pass forwards and medialwards and open into the straight sinus and into the great cerebral vein. Some pass lateralwards to open into the superior petrosal sinus or transverse sinus. The *inferior cerebellar veins* drain the inferior surface of the cerebellum and open into the occipital, transverse, and superior petrosal sinuses.

The *veins of the pons* pass upwards to end in the basal vein. The *veins of the medulla oblongata* communicate with the veins of the pons above and those of the medulla spinalis below. On the posterior surface of the medulla oblongata they also communicate below with the veins of the spinal medulla and terminate above in the inferior petrosal sinus.

Dissection. The dissector should now remove the membranes and blood vessels from the surface of the brain. This dissection should be done with forceps and scissors, and over the lateral surface of the cerebrum it can be effected with ease. Over the base of the brain this must be done with caution and special care should be taken at the points where the cerebral nerves are attached to the brain. The pia mater over the medulla oblongata should not be removed until the nerve roots have been examined. At the present stage of dissection it is not necessary that the membranes should be removed from the entire brain, but the student may remove them from the different parts of the organ as the dissection proceeds.

General Divisions of the Brain..—The mass of nervous matter contained in the cavity of the cranium and known as the brain may be divided into three parts :—(1) Forebrain (prosencephalon) which includes the cerebral hemispheres with the cavities inside them called the lateral ventricles and the third ventricle together with the structures bounding it ; (2) the midbrain (mesencephalon which connects the forebrain with the hind brain and consists of the cerebral peduncles, the corpora quadrigemina and the cerebral aqueduct ; (3) the hind brain (rhombencephalon) which includes the medulla oblongata, the pons and the cerebellum together with the fourth ventricle.

THE BASE OF THE BRAIN

The base of the brain should be studied as a whole. Omitting for the present the superficial attachments of the cerebral nerves the following parts are to be examined :—(1) The anterior end of the longitudinal fissure ; (2) the inferior surface of the frontal lobe on either side of the longitudinal fissure together with the olfactory tract and bulb ; (3) the rostrum or anterior terminal part of the corpus callosum ; (4) the lamina terminalis ; (5) the optic chiasma and the optic tracts ; (6) the anterior perforated substance ; (7) the tuber cinereum ; (8) the infundibulum and the hypophysis ; (9) the corpora mamillaria ; (10) the posterior perforated substance ; (11) the inferior surfaces of the temporal lobes ; (12) the peduncles of the cerebrum ; (13) the anterior surfaces of the pons and the medulla oblongata ; (14) the inferior surface of the cerebellum.

Of these the longitudinal fissure, the anterior perforated substance and the inferior surfaces of the frontal and temporal lobes will be examined when the cerebral hemispheres are studied. The rostrum will be examined with the corpus callosum.

The **Lamina Terminalis** (Lamina cinerea) will be seen if the hemispheres are gently separated from each other and the optic chiasma is drawn backwards. It is a thin layer of grey matter which passes downwards and backwards from the rostrum of the corpus callosum to the upper surface of the optic chiasma. At a later stage of the dissection it will be seen to form the anterior boundary of the third ventricle.

The **Optic Chiasma** (Optic commissure) is a short commissural band which connects the two optic tracts. In it the decussation of the medial fibres of the optic nerves takes place. From its postero-lateral angles the *optic tracts* pass backwards and lateralwards winding round the cerebral peduncles. The optic chiasma receives the optic nerves at its antero-lateral angles.

The **Interpeduncular Fossa** is a lozenge-shaped space bounded anteriorly by the optic chiasma, antero-laterally by the optic tracts, posteriorly by the pons, and postero-laterally by the cerebral peduncles. This space corresponds to the floor of the ventricle and contains the following structures from before backwards :—the tuber cinereum with infundibulum, hypophysis, corpora mamillaria, the posterior perforated substance, and the oculomotor nerves.

The **Tuber Cinereum** is a slight eminence of grey substance placed immediately behind the optic chiasma and between the optic tracts.

The **Infundibulum** is a hollow conical process which projects downwards from the tuber cinereum and becomes attached to the posterior lobe of the hypophysis.

The **Hypophysis** (Pituitary body) is an oval reddish grey mass which is lodged in the fossa hypophyseos of the sphenoidal bone where it is retained by the diaphragma sellæ. Its long axis is transverse and it is somewhat flattened from above downwards. It consists of a larger anterior and a smaller posterior lobe. The anterior lobe is developed as a pouch from the buccal cavity of the embryo and presents a concavity behind where the posterior lobe is received. The anterior lobe is again subdivided by a narrow cleft into an anterior part, *pars anterior*, and an intermediate part, *pars intermedia*. The posterior lobe is developed from the brain and is connected with the tuber cinereum by the infundibulum. Divide the hypophysis anteroposteriorly and note the junction of the anterior and posterior lobes.

The **Corpora Mamillaria** (Corpora albicantia) are two small rounded white bodies, each of the size of a small pea. They are placed side by side behind the tuber cinereum. They consist of white substance externally and grey substance internally. Their connections with the columns of the fornix and the thalamus will be traced later on.

The **Posterior Perforated Substance** (Posterior perforated space) is composed of grey substance and is so called on account of its being perforated by numerous small apertures for the passage of vessels, viz., the postero-medial ganglionic arteries. It is situated between the corpora mamillaria in front and the diverging cerebral peduncles behind.

The cerebral peduncles, the anterior surfaces of the pons and medulla oblongata, and the inferior surface of the cerebellum will be studied later on.

It has already been noted that there are twelve pairs of cerebral nerves. Each of them is attached to the surface of the brain at a particular area which is called the superficial origin of the nerve. In the case of motor nerves they really issue out of the brain at the areas of superficial origins whereas in the case of sensory nerves they really enter the brain at those areas to gain the interior of the brain. Strictly speaking therefore, the

superficial origin should be called the *superficial attachment* of a cerebral nerve. If these nerves are traced from their superficial attachments inside the brain they will be found to be connected with nuclei of grey substance in the interior of the brain. These nuclei are called the *nuclei of origin* in the case of motor nerves and the *nuclei of termination* in the case of the sensory nerves.

A thirteenth pair of cerebral nerves has been described. This pair, called the *nervi terminales*, is associated with the olfactory nerves. Each nervus terminalis is attached to the anterior perforated substance posterior to the medial olfactory stria and runs with the corresponding olfactory tract on its medial side to be distributed to the nasal mucous membrane like the olfactory nerve filaments.

Superficial Attachments of the Cerebral Nerves.—The attachment of the *olfactory nerves* to the olfactory bulb has been examined. The *optic nerve* joins the antero-lateral angle of the optic chiasma. The *oculomotor nerve* is attached to a groove, called the oculomotor sulcus, on the medial aspect of the cerebral peduncles. The *trochlear nerve* is attached to the dorsal aspect of the midbrain behind the corpora quadrigemina. It winds round the lateral side of the cerebral peduncle to reach the base of the brain. The *trigeminal nerve* consists of a large sensory root and a small motor root. Both are attached to the ventral surface of the pons near its upper border. The motor root lies in front of and medial to the sensory root at the sites of their attachments. The *abducent nerve* is attached to the groove between the lower border of the pons and the upper end of the pyramid of the medulla oblongata. The *facial* (consisting of motor and sensory parts) and *acoustic* (consisting of ventral and dorsal roots) *nerves* are attached to the groove below the lateral part of the lower border of the pons; the former nerve lying medial to the latter. The *glossopharyngeal, vagus* and *accessory nerves* are attached in a continuous line by filaments to the postero-lateral sulcus of the medulla oblongata. The spinal part of the accessory nerve is derived from the medulla spinalis. The *hypoglossal nerve* is attached by many filaments to the antero-lateral sulcus of the medulla oblongata.

THE SURFACES OF THE CEREBRAL HEMISPHERES

Each cerebral hemisphere is an ovoid mass and is incompletely separated from its fellow of the opposite side by a median

cleft called the *longitudinal fissure*. The surfaces of the hemispheres are mapped out by eminences called *convolutions* or *gyri* separated from each other by furrows called *fissures* or *sulci*. The arrangement of the gyri and the sulci vary not only in different brains but also in the two hemispheres of the same brain. Their general arrangement, however, is sufficiently constant.

Each hemisphere presents three surfaces, four borders and three poles. The *lateral surface* is convex and fits into the concavity of the vault of the cranium. The *medial surface* is flat and is separated from that of the opposite hemisphere by the falx cerebri. The *inferior surface* is irregular and may be subdivided into three portions corresponding to their situation. Thus the anterior portion is formed by the inferior or orbital surface of the frontal lobe. It is concave and lies on the roof of the orbit. The middle portion is formed by the inferior surface of the temporal lobe. It is convex and lies in the middle cranial fossa. The posterior portion is formed by the inferior or tentorial surface of the occipital lobe. It is concave and lies on the tentorium cerebelli. The borders separating these surfaces from each other are :—(1) The *superomedial border* which separates the lateral from the medial surface. (2) The *inferolateral border* which separates the lateral from the inferior surface ; the front part of this border separating the lateral from the orbital surface is called the *superciliary border*. About two inches in front of the posterior end of the hemisphere there is a notch in the inferolateral border called the *preoccipital notch*. (3) The *medial orbital border* separates the medial surface from the orbital part of the inferior surface. (4) The *medial occipital border* separates the medial surface from the tentorial part of the inferior surface of the occipital lobe. The anterior end of each hemisphere is called the *frontal pole* and the posterior end, the *occipital pole*. The anterior end of the temporal lobe is called the *temporal pole*. Structurally the cerebral hemispheres are composed of an outer layer of grey substance or *cortex* and an inner layer of white or *medullary substance*. In addition there are certain collections of grey substance towards the base of each hemisphere called the *basal ganglia*.

The **Longitudinal Cerebral Fissure** is the antero-posterior cleft in the median plane between the two cerebral hemispheres. In front and behind it completely separates the two hemispheres, but in its middle portion, the great transverse commissural band,

the corpus callosum, forms its floor and connects the hemispheres together. The falx cerebri projects into it.

The fissures on the cerebral hemispheres are of two kinds, complete and incomplete. The *complete fissures* are produced by infoldings of the whole thickness of the brain wall producing corresponding elevations in the brain cavity. Portions of the chorioidal, calcarine and collateral fissures are complete fissures. The *incomplete fissures* cause indentations on the cortical grey substance and the subjacent white substance without producing elevations in the brain cavity. The fissures are also classified into interlober and intralobar ; the former demarcate the different lobes from each other ; the latter demarcate the different gyri in a particular lobe.

The interlobar fissures on the lateral surface of each cerebral hemisphere are : (1) the lateral fissure, (2) the central sulcus, (3) the parieto-occipital fissure, and (4) the circular sulcus.

The **Lateral Cerebral Fissure** (fissure of Sylvius) begins at the inferior surface of the hemisphere and terminates on its lateral surface. It consists of a stem and three rami. The *stem* begins at the anterior perforated substance and passes lateralwards between the orbital surface of the frontal lobe and the anterior end of the temporal lobe. Reaching the lateral surface of the hemisphere it divides into three rami, the anterior horinzontal, the anterior ascending, and the posterior. The *anterior horizontal ramus* passes horizontally forwards for about an inch into the lower part of the lateral surface of the frontal lobe. The

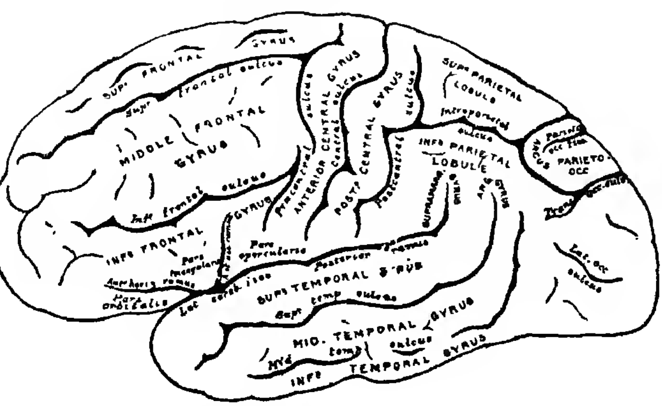


Fig. 131.—Lateral surface of the left cerebral hemisphere, viewed from the side (after Gray).

anterior ascending ramus ascends almost vertically into the lower part of the lateral surface of the frontal lobe for about an inch. The *posterior ramus* is the continuation backwards and upwards of the stem. It is about three inches (7.5 cm.) in length and lies between the frontal and parietal lobes above and the temporal lobe below. Its terminal portion is bent upwards into the lower part of the parietal lobe.

The **Central Sulcus** (fissure of Rolando) commences at or near the longitudinal fissure a little behind its middle and runs obliquely downwards and forwards along the lateral surface of the cerebral hemisphere to terminate a little above the posterior ramus of the lateral fissure at the junction of its anterior and middle thirds. In its course it presents two bends; the upper bend is called the *superior genu* and has its concavity directed forwards; the lower bend is called the *inferior genu* and has its concavity directed backwards. This fissure separates the frontal lobe from the parietal lobe on the lateral surface.

Parietooccipital Fissure.—A small portion of it is seen on the lateral surface of the cerebral hemisphere and is called the lateral part; the greater portion of it is situated on the medial surface and is called the medial part. The *lateral part* passes lateralwards for about half an inch from the longitudinal fissure and is situated about one inch and a half to two inches in front of the occipital pole. The *medial part* passes downwards and forwards on the medial surface of the hemisphere and meets the calcarine fissure behind the splenium.

The **Circular Sulcus** (limiting sulcus of Reil) surrounds the insula which lies concealed in the lateral fissure. On separating the upper and lower boundaries of the posterior ramus of the lateral fissure the insula will be exposed. The circular sulcus presents three limbs: an *upper limb* separating the insula from the frontal and parietal lobes; a *lower limb* separating it from the temporal lobe; and an *anterior limb* separating it from the orbital surface of the frontal lobe (Fig. 135).

The lobes of each cerebral hemisphere are:—(1) frontal, (2) parietal, (3) temporal, (4) occipital, (5) limbic, and (6) the insula.

Frontal Lobe.—On the lateral surface of the hemisphere, the frontal lobe is bounded behind by the central sulcus, below by the posterior ramus of the lateral fissure. Its inferior or orbital surface is bounded behind by the stem of the lateral fissure. Its medial surface is not demarcated from that of the parietal lobe by any fissure but a line drawn from the upper end of the

central sulcus vertically downwards along the medial surface serves as the boundary line between the medial surfaces of the two lobes.

The lateral surface of the frontal lobe presents three main sulci which map out four gyri. The sulci are :—(1) The *precentral sucus* which lies in front of the central sulcus and parallel to it. It consist of two parts, an upper and a lower which are usually not connected with each other. (2) The *superior frontal sulcus* passes almost horizontally forwards from the upper part of the precentral sulcus. (3) The *inferior frontal sulcus* passes forwards and slightly downwards from the lower part of the precentral sulcus. The gyri are :—(1) The *anterior central gyrus* (ascending frontal convolution) which lies between the central and precentral sulci. It is the *motor area* of the cortex. (2) The *superior frontal gyrus* lies above the superior frontal sulcus and encroaches on the medial surface. It is frequently subdivided into an upper and a lower part by an antero-posterior furrow called the *paramedial frontal sulcus.* (3) The *middle frontal gyrus* lies between the superior and inferior frontal sulci and is limited behind by the precentral sulcus.. This gyrus is also frequently subdivided into an upper and a lower one by the *medial frontal sulcus* of Eberstaller. (4) The *inferior frontal gyrus* lies in front of the precentral sulcus and below the inferior frontal sulcus. It is limited below by the superciliary border which separates it from the orbital surface. This gyrus is subdivided into three parts by the anterior horizontal and anterior ascending rami of the lateral fissure. The portion lying below the anterior horizontal ramus is called the *pars orbitalis.* The portion lying between the anterior horizontal and anterior ascending rami is called the *pars triangularis.* The portion lying behind the anterior ascending ramus is called the *pars basilaris.* The left inferior frontal gyrus is called Broca's convolution as Broca localised it as the centre for articulate speech.

The inferior or orbital surface of the frontal lobe presents two sulci ; the olfactory sulcus and the H-shaped orbital sulcus. The *olfactory sulcus* lies close to the medial orbital border and lodges the olfactory tract and bulb. The H-shaped *orbital sulcus* lies lateral to the olfactory sulcus and presents two antero-posterior limbs, one medial and the other lateral, connected in the middle by a transverse limb like H. The orbital surface of the frontal lobe is mapped out into five gyri. (1) The

gyrus rectus lies between the medial border and the olfactory sulcus. (2) The *medial orbital gyrus* lies between the olfactory sulcus and the medial limb of the H-shaped orbital sulcus. The gyrus rectus and the medial orbital gyrus are continuous with the superior frontal gyrus on the lateral surface of the hemisphere. (3) The *anterior orbital gyrus* lies in front of the transverse limb of the orbital sulcus. It is continuous with the middle frontal gyrus. (4) The *lateral orbital gyrus* lies lateral to the lateral limb of the orbital sulcus and is continuous with the inferior frontal gyrus. (5) The *posterior orbital gyrus* lies behind the transverse limb of the orbital sulcus. It is also continuous with the inferior frontal gyrus on the lateral surface.

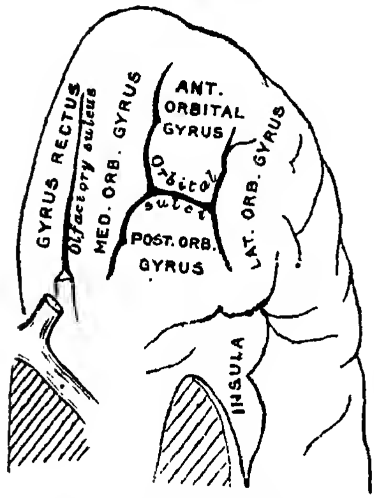


Fig. 132.—Orbital surface of the left frontal lobe (Gray).

The medial surface of the frontal lobe will be studied later on.

Parietal Lobe.—The lateral surface of the parietal lobe is bounded in front by the central sulcus, behind by the lateral part of the parietooccipital fissure and by a line drawn from the lower extremity of this fissure to the preoccipital notch, below by the posterior ramus of the lateral fissure and an imaginary line drawn backwards in continuation of the same ramus to meet the posterior boundary. It presents the following sulci :—(1) The *postcentral sulcus* which lies behind and parallel to the central sulcus. It is usually interrupted in the middle and is then discribed as consisting of an upper and a lower branch. (2) The *intraparietal sulcus* passes almost horizontally backwards from the middle of the postcentral sulcus. It is prolonged behind into the occipital lobe as the *occipital ramus* of the intraparietal sulcus and terminates by joining the transverse occipital sulcus behind the lateral parietoccipital fissure. Sometimes there is an interruption between the occipital ramus and the intraparietal sulcus. The gyri on the lateral surface of the parietal lobe are:—

(1) The *posterior central gyrus* (ascending parietal convolution) which lies between the central sulcus in front and the postcentral sulcus behind. It is continuous in front with the anterior central gyrus round the upper and lower ends of the central sulcus. It is the cortical area for general sensibility (*sensory area*). (2) The *superior parietal lobule* is bounded in front by the upper part of the postcentral sulcus and is continuous in front with the posterior central gyrus above the upper end of that sulcus. Behind it is the lateral parietooccipital fissure ; below the lower end of this fissure it is connected with the occipital lobe by a connecting gyrus called the *arcus parietooccipitalis ;* below it is bounded by the intraparietal sulcus. (3) The *inferior parietal lobule* is bounded in front by the lower part of the post-central sulcus, above by the intraparietal sulcus, below by the lower boundary of the parietal lobe and behind by the imaginary line which bounds the parietal lobe posteriorly. This lobule is further subdivid d into two gyri, viz., (*a*) the *supramarginal gyrus* which lies around the upturned end of the posterior ramus of the lateral fissure and is continuous in front with the posterior central gyrus and behind with the superior temporal gyrus ; (*b*) the *angular gyrus* which lies around the upturned end of the superior temporal sulcus.

The medial surface of the parietal lobe will be studied later on.

The **Occipital Lobe** forms the posterior part of the hemisphere. Its lateral surface is bounded in front by the lateral part of the parietooccipital fissure and by a line drawn from its lower end to the preoccipital notch. The sulci on its lateral surface are :—(1) The *transverse occipital sulcus* which lies behind the lateral part of the parietooccipital fissure and which is joined in front by the occipital ramus of the intraparietal sulcus. (2) The *lateral occipital sulcus* passes from behind forwards on the lateral surface of the occipital lobe. The gyri on its lateral surface are :—(1) The *superior occipital gyrus* which lies above the lateral occipital sulcus. (2) The *inferior occipital gyrus* lies below the same sulcus. (3) The *arcus parietooccipitalis* lies in front of the transverse occipital sulcus and has been already described.

The inferior or tentorial surface of the occipital lobe is continuous in front with the inferior surface of the temporal lobe and is demarcated from it by an imaginary line passing transversely medialwards from the preoccipital notch. This surface

presents the posterior part of the collateral fissure which runs from behind forwards into the temporal lobe and separates the posterior parts of the lingual and fusiform gyri. The *fusiform gyrus* lies laterally while the *lingual gyrus* lies medially and encroaches on the medial surface of the occipital lobe.

The medial surface of the occipital lobe will be studied later on.

The **Temporal Lobe** is situated below the posterior ramus of the lateral fissure and in front of the occipital lobe. Its lateral surface is mapped out into three gyri by two sulci. The sulci are :—(1) The *superior temporal sulcus* (parallel sulcus) which lies below the posterior ramus of the lateral fissure and runs parallel to it. It extends from near the temporal pole to a point a little behind the upturned end of the posterior ramus of the lateral fissure. (2) The *middle temporal sulcus* lies below the preceding and runs parallel to it. It is often interrupted in the middle. The gyri are :—(1) The *superior temporal gyrus* which lies between the posterior ramus of the lateral fissure and the superior temporal sulcus. It is continuous behind with the supramarginal gyrus. (2) The *middle temporal gyrus* lies between the superior and middle temporal sulci. It is continuous behind with the angular gyrus. (3) The *inferior temporal gyrus* lies below the middle temporal gyrus and is continuous behind with the inferior occipital gyrus.

The inferior surface of the temporal lobe presents the following sulci :—(1) The *inferior temporal sulcus* which lies most laterally and runs anteroposteriorly between the temporal and occipital poles. It is often interrupted and it separates the inferior temporal gyrus laterally from the fusiform gyrus lying medially. (2) The *collateral fissure* lies medial to the fusiform gyrus and separates it from the lingual gyrus behind and the hippocampal gyrus in front. Behind it is continued along the inferior surface of the occipital lobe and in front it terminates a little behind the temporal pole. (3) *Chorioidal fissure.*—A portion of this fissure is seen extending from below the splenium towards the anterior end of the temporal lobe. It forms the upper and medial boundary of the inferior surface of the temporal lobe and through it a vascular fold of pia mater, the chorioid plexus, enters the inferior cornu of the lateral ventricle. The gyri on the inferior surface of the temporal lobe are :—(1) The *inferior temporal gyrus* which lies lateral to the inferior temporal sulcus and is continuous with the same gyrus seen

on the lateral surface. (2) The *fusiform gyrus* lies between the inferior temporal sulcus and the collateral fissure. Behind it is continuous with the inferior surface of the occipital lobe. (3) The *hippocampal gyrus* lies between the collateral and chorioidal fissures. Its anterior extremity is bent upwards on itself like a hook and is called the *uncus*. The uncus is separated from the temporal pole by a slight cleft called the *incisura temporalis*. Behind and below the hippocampal gyrus is continuous with the lingual gyrus ; behind and above, with the cingulate gyrus lying above the corpus callosum. The cortical area for the sense of taste is in the hippocampal gyrus and the uncus.

The superior surface of the temporal lobe presents some gyri concealed in the posterior ramus of the lateral fissure. These gyri pass from behind forwards and lateralwards and are called the *transverse temporal gyri* and they overlap the insula. The anterior transverse temporal gyrus and the middle third of the superior temporal gyrus together form the cortical centre for auditory sensation or hearing (*audito-sensory area*).

Limbic Lobe.—This name is given to certain gyri lying in continuity on the medial surface of each hemisphere. These gyri will be studied when the medial surface of the cerebral hemisphere is examined.

The **Insula** (Island of Reil) (Fig. 135) lies concealed at the bottom of the lateral fissure. To see the insula it is necessary to separate widely the lips of that fissure. It is then seen as a somewhat triangular eminence with its apex at the commencement of the stem of the lateral fissure. The insula is surrounded by the circular sulcus. The gyri which bound the lateral fissure overlap and hide the insula and are called the *opercula of the insula*. These opercula, four in number, are separated from each other by the three limbs of the lateral fissure and are named the orbital, frontal, frontoparietal, and temporal opercula. The *orbital operculum* lies below the anterior horizontal ramus of the lateral fissure. The *frontal operculum* lies between the anterior ascending and anterior horizontal rami. The *frontoparietal operculum* lies between the anterior ascending ramus and the terminal part of the posterior ramus of the lateral fissure. The *temporal operculum* lies below the posterior ramus and is formed by the upper margin of the superior temporal gyrus.

Gyri of the insula.—These are best displayed when the opercula are removed. The surface of the insula is sub-

divided by a sulcus called the *sulcus centralis insulæ*. It runs from the apex of the insula upwards and backwards. The gyri lying in front of the sulcus are three or four in number and are called *short gyri* while the gyrus lying behind the sulcus is long and is called the *long gyrus*.

The olfactory lobe should be studied now.

Olfactory Lobe.—This name is given to the following parts lying in continuity :—(1) The olfactory bulb, (2) the olfactory tract, (3) the olfactory trigone, (4) the parolfactory area of Broca, and (5) the anterior perforated substance.

The *olfactory bulb* is the enlarged anterior end of the olfactory tract. It lies in the groove on the upper surface of the lamina cribrosa of the ethmoidal bone. To its lower surface are attached the olfactory nerve filaments.

The *olfactory tract* is the narrow part behind the olfactory bulb. It lies in the olfactory sulcus on the orbital surface of the frontal lobe. It is triangular on section, the apex of the triangle being received into the olfactory sulcus.

The *olfactory trigone* is the triangular elevation at the back part of the olfactory tract and in front of the anterior perforated substance. From the lateral angle of the olfactory trigone the *lateral olfactory stria* passes along the lateral margin of the anterior perforated substance to the uncus of the hippocampal gyrus. From the medial angle of the olfactory trigone the *medial olfactory stria* passes along the medial aspect of the trigone medialwards to the subcallosal gyrus situated beneath the anterior part of the corpus callosum.

The *parolfactory area of Broca* is a small triangular area situated in front of the subcallosal gyrus on the medial surface of the hemisphere and separated from it by a sulcus called the *posterior parolfactory sulcus*.

The *anterior perforated substance* is so called on account of its being perforated by blood vessels, viz., the anterolateral ganglionic arteries. It is bounded in front by the olfactory trigone, behind by the optic tract, laterally by the lateral olfactory stria and medially by the medial olfactory stria.

Dissection. The medial surface of the cerebral hemisphere is now to be studied. For this the left hemisphere is to be sliced off with a long knife about half an inch above the level of the corpus callosum. The cut surface presents an oval mass of white matter surrounded on all sides by a convoluted layer of grey substance. This oval area is called the *centrum ovale*

minus and its surface is spotted with red dots (puncta vasculosa) which are the cut ends of minute blood vessels.

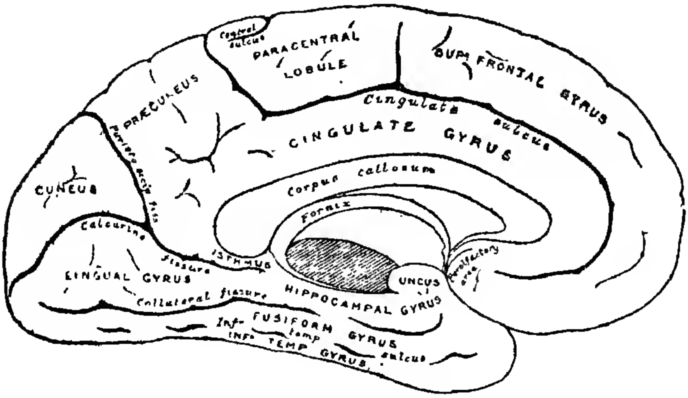


Fig. 133.—Medial surface of the left cerebral hemisphere (after Gray).

Medial Surface of the Cerebral Hemisphere.—The fissures and sulci on the medial surface are:—(1) The *callosal sulcus* which is a slit-like interval lying between the convex surface of the corpus callosum and the overlying gyrus. (2) The *cingulate sulcus* begins below the anterior end of the corpus callosum and runs forwards and upwards; it then curves in front of the genu and passes backwards parallel to the callosal sulcus being separated from that sulcus by the cingulate gyrus. Its posterior end turns upwards and cuts the superomedial border behind the upper end of the central sulcus. Opposite the upper end of the precentral sulcus it sends an offset towards the superomedial border. (3) The *medial part of the parietooccipital fissure* has been described with the parietooccipital fissure. (4) The *calcarine fissure* is a complete fissure. It begins close to the occipital pole and, running forwards and slightly upwards, joins the parietooccipital fissure a little behind the splenium. It continues its course further forwards and ends below the splenium. The anterior part of this fissure gives rise to the eminence called the calcar avis in the lateral ventricle. The posterior and anterior parts of this fissure are developed separately at first and then become combined. The student will find proof of this if he opens up the fissure behind its union with the parieto-occipital fissure; he will then see a small gyrus, the *cuneolingual gyrus,* separating the anterior and posterior portions of this

fissure. The calcarine fissure is functionally important for although the cortex of the occipital lobe in general is concerned with visual sensation the cortical area around the calcarine fissure is specially known as the *visual area* of the cortex. This portion of the cortical area presents a different appearance on section. If a coronal section of the occipital lobe is made across the posterior part of the calcarine fissure in a well preserved brain, a fine white line will be seen subdividing the grey substance round the calcarine fissure into an outer and an inner layer. This white line is called the *stria Gennari* (band of Gennari) and the cortical area showing this stria is called the *area striata*. (5) The *subparietal sulcus* lies between the posterior end of the cingulate sulcus and the medial part of the parietooccipital fissure and separates the precuneus from the cingulate gyrus. It is in the same line with the back part of the cingulate sulcus excluding its upturned end.

The gyri on the medial surface of the cerebral hemisphere are :—(1) The *superior frontal gyrus*, part of which has been seen on the lateral surface of the hemisphere. On the medial surface it lies between the cingulate sulcus below and the superomedial border above Behind it is limited by the offset from the cingulate sulcus which passes upwards towards the upper end of the precentral sulcus. (2) The *paracentral lobule* is bounded in front by the offset of the cingulate sulcus and behind by the upturned end of the same sulcus. It is continuous with the anterior and posterior central gyri. (3) The *precuneus* or *quadrate lobe* corsesponds to the medial surface of the superior parietal lobule. It is bounded in front by the upturned end of the cingulate sulcus, behind by the medial part of the parietoocci-pital fissure, above by the superomedial border and below by the subparietal sulcus. (4) The *cuneus* is a wedge-shaped or triangular gyrus lying between the medial part of the parieto-occipital fissure and the calcarine fissure. (5) The *lingual gyrus* lies between the calcarine and collateral fissures.It occupies both the medial and inferior surfaces of the hemisphere. It is continuous in front with the hippocampal gyrus. (6) The *cingulate gyrus* is a curved convolution lying between the callosal fissure below and the cingulate and subparietal sulci above. It surrounds the corpus callosum and is connected behind the splenium with hippocampal gyrus by a narrow gyrus, called the *isthmus*, which lies between the splenium and the anterior end of the calcarine fissure.

Limbic Lobe.—The cingulate gyrus together with the hippocampal gyrus and the isthmus form a continuous gyrus which was described by Broca as the limbic lobe.

Dissection. Part of the cingulate gyrus of the left cerebral hemisphere still covers the corpus callosum. Divide the whole depth of the cingulate gyrus about the middle by a transverse cut. Lift the cut ends with fingers and throw them forwards and backwards. On the deep surface of the raised cingulate gyrus a bundle of longitudinal white fibres will be seen embedded in its substance. This bundle is called the cingulum. Detach this bundle from the deep surface of the cingulate gyrus and note its connections anteriorly and posteriorly by pulling it.

The *cingulum* is a longitudinal bundle of association fibres which lies in the substance of the cingulate gyrus. It begins in front at the anterior perforated substance, proceeds forwards and upwards above the rostrum and then turns round the genu ; it next proceeds backwards over the body of the corpus callosum and, winding round the splenium, terminates posteriorly in the hippocampal gyrus.

THE INTERIOR OF THE CEREBRAL HEMISPHERES

Dissection. The gyri from the right cerebral hemisphere are now to be removed above the level of the corpus callosum. Insert the fingers into the callosal fissure above the corpus callosum and peel off the cingulate gyrus in a lateral direction and note the manner in which the fibres of the corpus callosum pass into the gyri of the brain. Both the hemispheres are then to be sliced off to the level of the upper surface of the corpus callosum. A large mass of white substance surrounded by convoluted grey substance is exposed. This is called the *centrum ovale majus*. The upper surface of the corpus callosum is well revealed now.

The **Corpus Callosum** is the great transverse commissure which connects the two cerebral hemispheres. It consists of a thick stratum of white substance composed mainly of transverse fibres. It is situated at the bottom of the longitudinal fissure and measures about four inches (10 cm.) antero-posteriorly. It is nearer to the frontal than to the occipital pole, and is thicker at the ends than at the middle. Its *superior surface* is convex from before backwards and forms the floor of the central portion of the longitudinal fissure ; it is touched by the

falx cerebri posteriorly but anteriorly that process does not descend low enough to reach it. It is covered by a very thin layer of grey substance, called the *supracallosal gyrus*, and is overlapped laterally by the cingulate gyrus. It presents along the middle line a faint antero-posterior groove. On either side of this groove is a thin linear elevation in the supracallosal gyrus formed by longitudinal fibres, called the *stria longitudinalis medialis*. Lateral to this on either side is another longitudinal linear elevation called the *stria longitudinalis lateralis*. The *inferior surface* forms the roof of the lateral ventricles; along its middle, the septum pellucidum is attached in front and the fornix, behind. The *anterior end* of the corpus callosum is bent and then reflected downwards and backwards; the bend is called the *genu* and the reflected portion, the *rostrum*. The rostrum gradually becomes thinner and is connected below with the lamina terminalis. The *posterior end* of the corpus callosum is the thickest part and is rounded and free; it is called the *splenium*.

The *supracallosal gyrus* or *indusium griseum* is a thin layer of grey matter covering the upper surface of the corpus callosum. Traced in front it is seen to be prolonged round the genu and the rostrum to be continuous with the subcallosal gyrus. Traced behind it is continued below the splenium as a thin ridge, called the *fasciola cinerea*, into the fascia dentata hippocampi.

The *fibres of the corpus callosum* run for the most part transversely. The transverse fibres enter the white substance of the cerebral hemisphere and radiate to the various parts of the cerebral cortex. The fibres from the genu on entering the hemisphere radiate forwards to the frontal pole forming what is called the *forceps anterior* (minor). The fibres from the splenium on entering the hemisphere pass backwards towards the occipital pole forming the *forceps posterior* (major). The intermediate fibres sweep across the roof and lateral wall of the lateral ventricle into the temporal lobe forming what is called the *tapetum*.

Dissection. To open the lateral ventricles a longitudinal incision should be made through the superior surface of the corpus callosum on either side of the middle line. Introduce the handle of the scalpel through this incision and raise the lateral portion of the corpus callosum with it. Remove this lateral portion of the corpus collosum by dividing it at its attachment laterally. The central portion and the anterior cornu

of the lateral ventricle are now exposed. Carry the knife backwards into the occipital pole dividing the roof of the posterior cornu. Remove a portion of its roof to expose it more fully. From the junction of the central portion and the posterior cornu of the lateral ventricle another cavity, called the inferior cornu, will be seen passing downwards and forwards through the temporal lobe up to its anterior end. Open up the inferior cornu by cutting through its lateral wall along the superior temporal sulcus ; this sulcus will serve well as the guide. When the inferior cornu has been opened up from the beginning to the end, part of its lateral wall should be removed to fully expose its roof and floor. The portion of the corpus callosum, which lies between the two longitudinal incisions, should not be disturbed now but kept in position.

The **Lateral Ventricles** are two irregular cavities one in each hemisphere of the brain and separated from each other

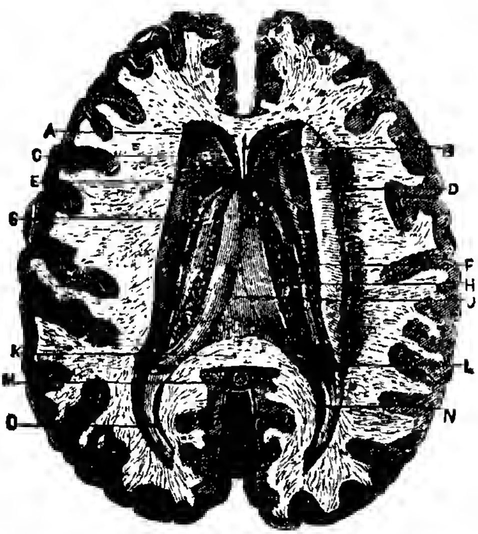


Fig. 134.—Lateral ventricles of the brain (from Hirschfeld and Leveille).

A. Septum pellucidum.
B. Cavum septum pellucidi.
C. Corpus striatum.
D. Corpus callosum, reflected.
E. Interventricular foramen.
F. Stria terminalis.
G. Thalamus.
H. Chorioid plexus.
J. Fornix.
K. Posterior extremity of corpus callosum.
L. Commencement of inferior cornu.
M. Great cerebral vein.
N. Calcar avis.
O. Posterior cornu of lateral ventricle.

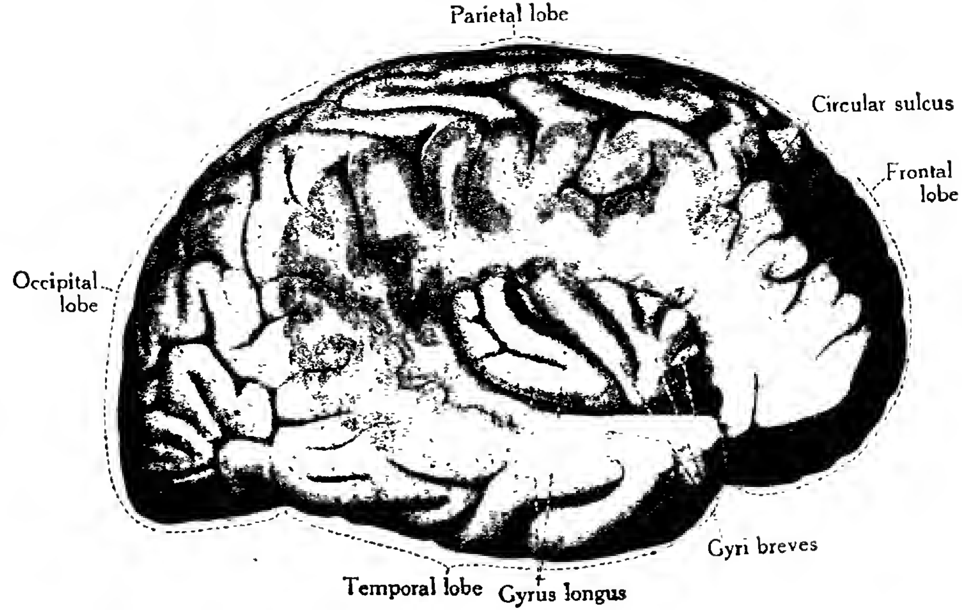


Fig. 135 —Fissures and gyri of the insula—exposed by removing the opercula (Sobotta).

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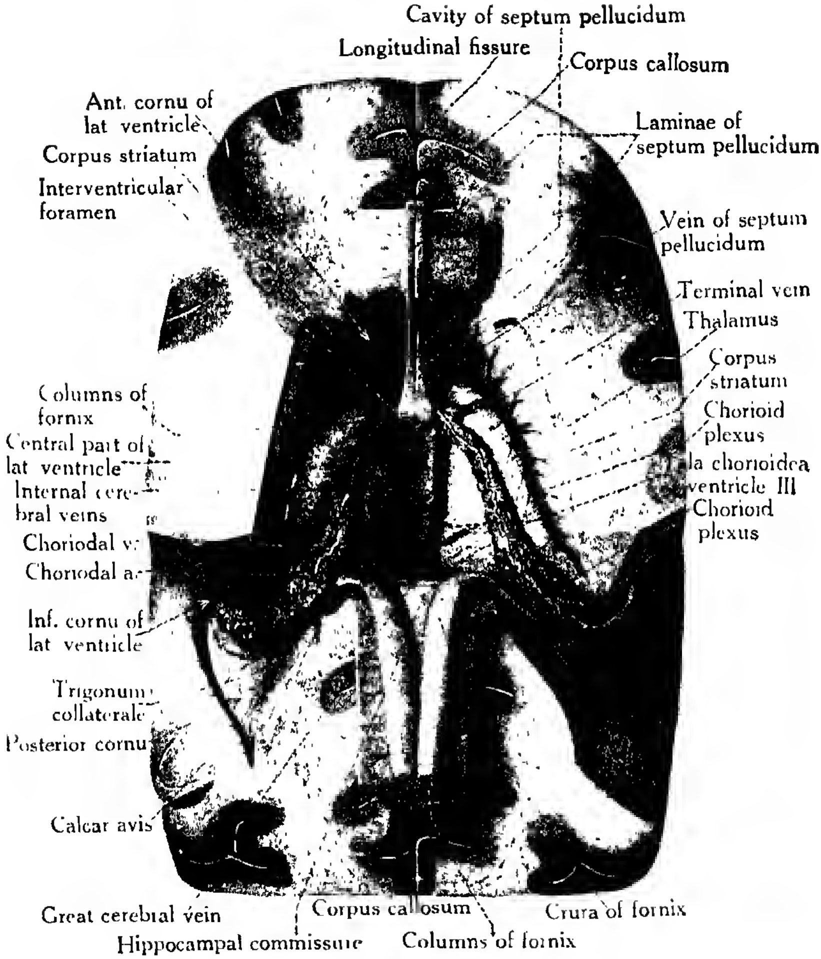

Fig. 136.—The lateral ventricles and the tela chorioidea of the third ventricle Sobotta).

by a median partition extending from the floor to the roof called the *septum pellucidum.* They are lined by a thin membrane called the *ependyma* and contain a serous fluid called the cerebrospinal fluid. They communicate with the third ventricle by an aperture, called the *interventricular foramen,* which is placed in front of the anterior end of the thalamus. Each lateral ventricle consists of a central part, an anterior cornu, a posterior cornu and an inferior cornu.

The **Central Part** (body) extends from the splenium of the corpus callosum behind to the interventricular foramen in front. Its *roof* is formed by the under surface of the corpus callosum and its *medial wall* by the back part of the septum pellucidum. *Laterally* the roof meets with the floor. Its *floor* is formed from before backwards by (1) the caudate nucleus, (2) the terminal vein, (3) the stria terminalis, (4) the thalamus, (5) the chorioid plexus, and (6) the fornix. The *caudate nucleus* is a mass of grey substance ; it is enlarged at its anterior end, called the head, which is directed into the anterior cornu ; it gradually tapers posteriorly forming the tail whch is prolonged into the inferior cornu. The *terminal vein* (vein of the corpus striatum) is placed in the same groove occupied by the stria terminalis ; it opens into the internal cerebral vein at the interventricular foramen. The *stria terminalis* (taenia semicircularis) lies in the groove between the caudate nucleus and the thalamus. It is a linear band of white substance which passes in front towards the interventricular foramen. Behind it passes into the roof of the inferior cornu. A very narrow portion of the lateral part of the upper surface of the *thalamus* is seen between the chorioid plexus and the stria terminalis. The *chorioid plexus* is a vascular fringe of pia mater which appears in the lateral ventricle between the lateral edge of the fornix and the thalamus. In front it is continuous with the chorioid plexus of the lateral ventricle of the opposite side through the interventricular foramen. Posteriorly it passes into the inferior cornu. Its surface is lined by the ependymal covering of the lateral ventricle. The lateral edge of the body of the *fornix* is seen in the central part of the lateral ventricle ; it is thin and it overlaps the chorioid plexus. Each lateral ventricle communicates with the third ventricle by means of an aperture called the *interventricular foramen* which is bounded in front by the column of the fornix and behind by the anterior end of the thalamus.

The **Anterior Cornu** (anterior horn) lies in front of the inter-

ventricular foramen. It passes forwards, lateralwards and slightly downwards into the frontal lobe. Its *roof* is formed by the front part of the corpus callosum ; its *floor* by the orbital part of the frontal lobe ; its *medial wall* by the front part of the septum pellucidum ; and its *lateral wall* by the head of the caudate nucleus.

The **Posterior Cornu** extends backwards into the occipital lobe. It is curved ; the convexity of the curve is directed lateralwards. Its *roof* and *lateral wall* are formed by the tapetum of the corpus callosum. Its *medial wall* presents two elongated elevations. The upper of the two is called the *bulb of the posterior cornu* and is formed by the fibres of the forceps posterior. The lower elevation is called the *calcar avis* (hippocampus minor) and is caused by the infolding of the ventricular wall of the anterior part of the calcarine fissure. The handle of the scalpel may be pushed through the fissure to verify it. The posterior extremity of the posterior cornu is tapering.

The **Inferior Cornu** (descending horn) of the lateral ventricle runs into the temporal lobe and passes at first backwards and lateralwards and then turns downwards and forwards and finally bends medialwards ending about an inch behind the temporal pole. Its *lateral wall* is formed mostly by the tapetum Its *medial wall* presents the lower part of the chorioidal fissure which is seen when the chorioid plexus is removed. Its *roof* is formed chiefly by the tapetum but the tail of the caudate nucleus also passes forwards in the roof to terminate in a small nucleus

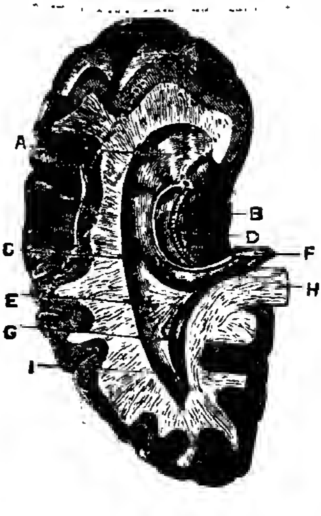

Fig. 137.—Inferior and posterior cornua of the lateral ventricle of brain (from Hirschfeld and Leveille).

A. Pes hippocampi.
B. Fimbria hippocampi.
C. Hippocampus.
D. Fascia dentata.
E. Eminentia collateralis.
F. Crus of fornix (cut).
G. Calcar avis (the forceps posterior is seen on the medial side of this in continuity with the splenium).
H. Splenium of corpus callosum (cut).
I. Posterior cornu.

of grey substance called the *amygdaloid nucleus*. This nucleus produces an elevation in the anterior end of the roof and if it is divided the grey colour of the nucleus will be seen. The stria terminalis also lies in the roof and terminates in the amygdaloid nucleus. The *floor* of the inferior cornu presents the following parts: (1) the hippocampus, (2) the fimbria hippocampi, (3) the collateral eminence, (4) the chorioid plexus, and (5) the trigonum collaterale. These parts should now be examined in detail.

The **Hippocampus** (hippocampus major) is an elongated conspicuous eminence, occupying the whole length of the floor of the inferior cornu. It rigidly follows the curve of the cornu and at its lower end becomes expanded and indented on the surface so as to resemble the paw of an animal. Hence this terminal portion is called the *pes hippocampi*. The amygdaloid nucleus lies on the roof opposite the pes hippocampi. The hippocampus is covered by the chorioid plexus. In structure it consists principally of grey substance but has a thin layer of white substance on the ventricular surface termed the *alveus*.

The **Fimbria Hippocampi** (corpus fibriatum, tænia hippocampi) is a narrow band of white substance which is attached to the medial concave border of the hippocampus. It is continuous above with the crus of the fornix and terminates below at the uncus. Its medial margin is free. Laterally it is continuous with the thin layer of white substance, called the alveus, already referred to

The **Collateral Eminence** is an elongated projection on the floor of the inferior cornu situated on the lateral side of the hippocampus. It is continuous behind with the triangular area called the trigonum collaterale. It is produced by an infolding of the ventricular wall corresponding to the middle part of the collateral fissure. The handle of the scalpel may be introduced into the collateral fissure to verify this.

The **Chorioid Plexus** is the vascular fringe of pia mater which has been pushed into the inferior cornu of the lateral ventricle through the chorioidal fissure. It is continuous behind the thalamus with the choroid plexus of the central part of the lateral ventricle. It is covered by the ependyma of the ventricle.

The *trigonum collaterale* is the smooth triangular space seen in the floor of the inferior cornu at the angle of divergence of the posterior and inferior cornua.

Dissection. Detach the remaining portion of the right occi-

pital and temporal lobes from the specimen of brain under examination by dividing (1) the forceps posterior and (2) the fimbria hippocampi at its junction with the crus of the fornix. Make an incision from the anterior extremity of the inferior cornu and carry it through the temporal pole. Now separate the temporal lobe with the hippocampal gyrus from the rest of the cerebrum. In the detached piece the floor of the inferior cornu can be more thoroughly examined. On raising the free margin of the frimbria hippocampi a narrow layer of grey substance is exposed, the surface of which is marked by many transverse ridges and furrows. This structure is called the fascia dentata hippocampi.

The *fascia dentata hippocampi* (dentate gyrus) lies on the upper surface of the hippocampal gyrus. Its free surface is marked by ridges and furrows and is covered by the fimbria hippocampi. The cleft between it and the fimbria hippocampi is called the *fimbrio-dentate sulcus*. Behind it is continuous with the fasciola cinerea beneath the splenium. In front it is continued into the uncus as a curved band called the *band of Giacomini*.

Dissection. Remove the central strip of corpus callosum which is adherent behind to the fornix and in front to the septum pellucidum. Next cut through the upper border of the septum pellucidum to exhibit the two laminæ of which it is composed.

The **Septum Pellucidum** (septum lucidum) is the partition between the anterior cornua and the anterior parts of the central portions of the lateral ventricles. It consists of two thin laminæ, separated from each other by a narrow chink called the *cavity of the septum pellucidum* (fifth ventricle). This cavity is considered to be a portion of the longitudinal cerebral fissure and does not communicate with the ventricles of the brain. The septum pellucidum is attached above to the under surface of the corpus callosum and below to the rostrum in front and to the fornix behind.

The **Fornix** (Figs. 136, 138) is a band of white substance situated below the corpus callosum. It extends from before backwards in the form of an arch, the convexity of which is directed upwards. It consists of two lateral halves, the central parts of which are joined together in the middle line while their anterior and posterior parts diverge from each other. The central joined parts constitute the body; the anterior parts are called the columns of the fornix; and the posterior parts, the crura.

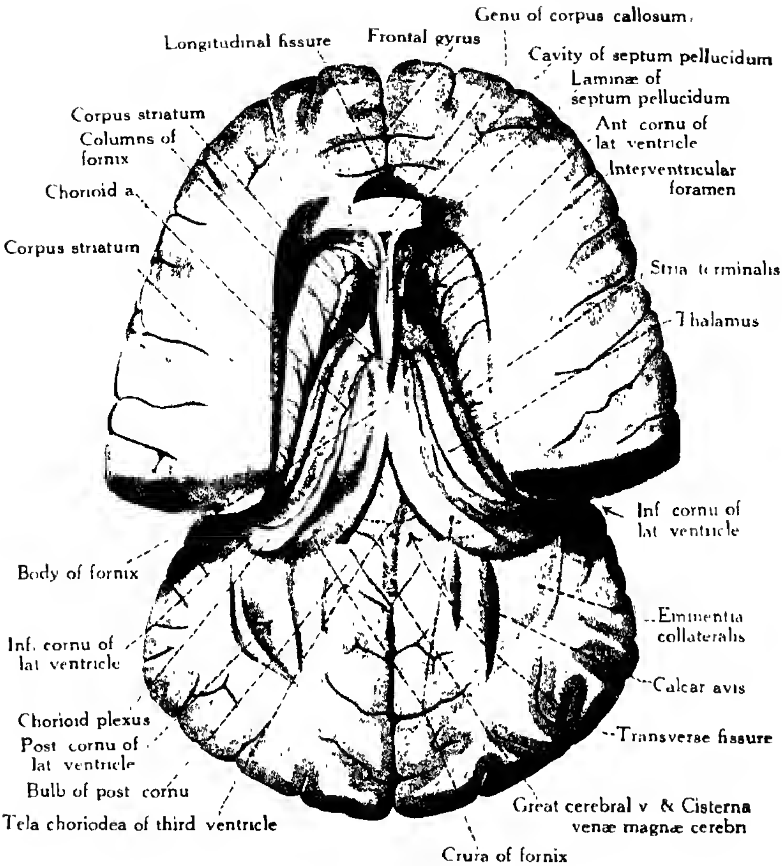

Fig. 138.—Horizontal section of the cerebral hemispheres showing the lateral ventricles, fornix and septum pellucidum (Sobotta).

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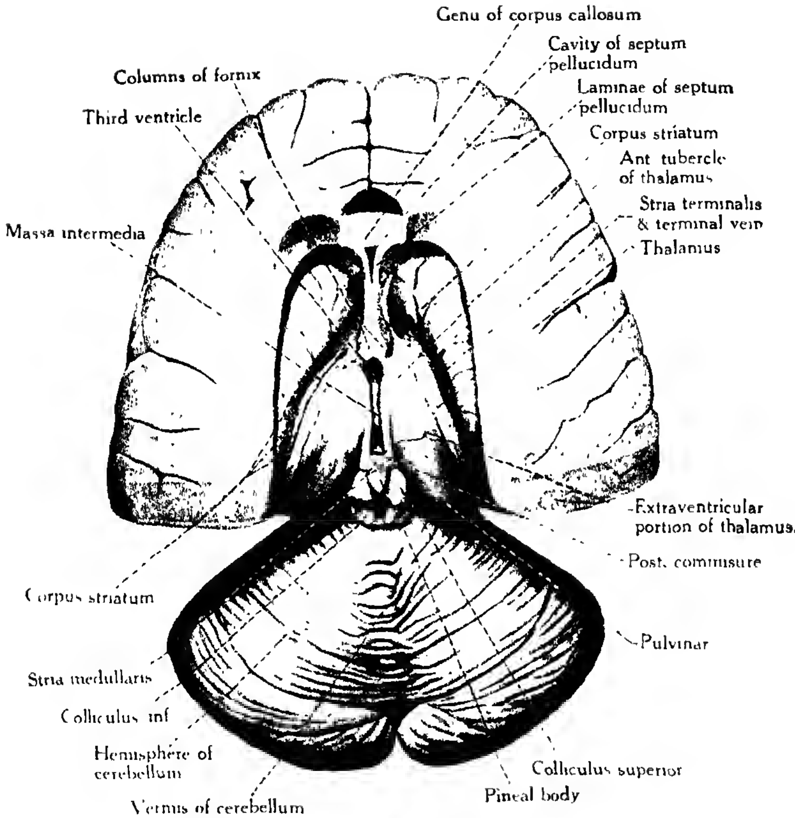

Fig. 139.—The two thalami and the third ventricle exposed from above (Sobotta).

The *body* of the fornix is triangular, being narrow in front and broad behind. Its upper surface, in the median line, is attached behind to the under surface of the corpus callosum and in front to the septum pellucidum. The lateral portions of the upper surface form the floor of the lateral ventricles. Its lower surface rests on the fold of pia mater which forms the roof of the third ventricle. Its lateral border is separated from the thalamus by the chorioid plexus.

The *columns* of the fornix (anterior pillars) pass downwards in front of the interventricular foramen. Each column passes under cover of the ependyma of the lateral wall of the third ventricle to the base of the brain to terminate in the corpus mamillare. From here a fresh bundle of fibres, called the *thalamomamillary fasciculus* (bundle of Vicq d'Azyr), arises and passes to the anterior tubercle of the thalamus. The course of the column along the lateral wall of the ventricle to the corpus mamillare and that of the thalamomamillary fasciculus, will be traced after the examination of the third ventricle.

The *crura* of the fornix (posterior pillars) are the posterior prolongations from the body of the fornix and are at first attached to the under surface of the corpus callosum. Each crus diverges from its fellow of the opposite side and curves lateralwards and downwards round the posterior end of the thalamus; it then proceeds into the inferior cornu of the lateral ventricle and lies along the concavity of the hippocampus. Some of its fibres spread out over the hippocampus forming the *alveus*; the remainder form a band and become continuous with the fimbria hippocampi in the inferior cornu of the lateral ventricle. If the body of the fornix is cut through transversely at its middle and the posterior portion thrown backwards, a triangular lamina will be seen between the diverging crura encroaching on the back part of the under surface of the body of the fornix. This lamina is called the *lyra* and it is traversed by transverse fibres connecting the two crura and through them the hippocampi of the two sides. These transverse fibres constitute a commissure called the *hippocampal com missure*.

The **Chorioidal Fissure** should now be studied in its entirety. Its lower part through which the chorioid plexus of the inferior cornu of the lateral ventricle enters has been studied. Its upper part begins at the interventricular foramen and passes backwards between the lateral margin of the body of the fornix and the upper surface of the thalamus. At the commencement of the

inferior cornu the fissure lies between the crus of the fornix and the posterior end of the thalamus. In the inferior cornu it lies between the stria terminalis on the roof and the fimbria hippocampi on the floor of the cornu. Through the fissure the chorioid plexus protrudes into the central part and into the inferior cornu of the lateral ventricle pushing the ependyma before it.

The **Tela Chorioidea of the Third Ventricle** (velum interpositum) is a double layer of pia mater which penetrates into the ventricles through the central portion of the transverse fissure beneath the splenium. It is placed beneath the body of the fornix forming the roof of the third ventricle. It is triangular in shape; its apex reaches as far forwards as the interventricular foramen; and its base lies under the splenium at the transverse fissure. Along its lateral margin is the chorioid plexus of the lateral ventricle which protrudes into the central portion of the lateral ventricle through the upper part of the chorioidal fissure. From its under surface, on either side of the middle line, a linear vascular fringe projects downwards into the third ventricle; this fringe is called the *chorioid plexus of the third ventricle.* Between the two layers of the tela chorioidea are contained the ***internal cerebral veins*** (veins of Galen) one on either side. Each of these veins is formed in front at the interventricular foramen by the union of the terminal vein with the chorioidal vein. Emerging from the chorioid plexus it proceeds backwards close to the median line, receives the basal vein of the same side and unites with its fellow of the opposite side forming the *great cerebral vein* (vena magna Galeni) which opens into the straight sinus.

The **Transverse Fissure of the Brain** is the cleft through which the invagination of the pia mater forming the tela choriodea of the third ventricle, and that of the chorioid plexus of the inferior cornu of the lateral ventricle into the interior of the brain takes place. It consists of a central and two lateral portions. The central portion lies between the splenium and body of the fornix above, and the midbrain below; the base of the tela chorioidea of the third ventricle lies along it. The two lateral portions coincide with the lower parts of the chorioidal fissure. The transverse fissure must be differentiated from the chorioidal fissure. The lateral portions of the former are the same as the lower portions of the latter, but the central portion of the transverse fissure does not coincide with the upper part of the chorioidal fissure. The upper part of the latter fissure lies between the lateral margin of the fornix and the thalamus.

THALAMENCEPHALON

The student should now examine the thalamus and certain parts lying in its neighbourhood, which together constitute the thalamencephalon.

Dissection. Divide the internal cerebral veins near the interventricular foramen. Raise the tela chorioidea by holding its apex with forceps and then throw it backwards. In reflecting the tela chorioidea be careful not to injure the pineal body which lies enveloped by the lower layer of the tela at its posterior part. When the tela is reflected backwards completely, the superior surfaces of the thalami are displayed as also the cavity of the third ventricle.

The **Thalamus** (optic thalamus) (Figs. 139, 140) is a large ovalshaped mass of grey substance coated on its superior surface by a thin layer of white substance called the *stratum zonale*. The thalami are two in number situated one on either side of the third ventricle. Each thalamus presents four surfaces and two ends. The *superior surface* is convex and is bounded laterally by the oblique groove which separates it from the caudate nucleus and contains the stria terminalis and the terminal vein. Medially this surface is bounded in its anterior half by a linear elevation called the *tænia thalami*—from the tænia the ependyma of the third ventricle is reflected to the under surface of the tela chorioidea. This surface is subdivided by an oblique groove, which corresponds to the lateral margin of the body of the fornix, into a lateral and a medial portion. The lateral portion forms the floor of the central part of the lateral ventricle. The medial portion is covered by the tela chorioidea of the third ventricle. The *inferior surface* rests upon the dorsal part of the cerebral peduncle. The *medial surface* forms the lateral wall of the third ventricle and is connected with the medial surface of the opposite thalamus by a soft mass of grey substance called the *massa intermedia* (middle commissure). The *lateral surface* lies against a band of white substance called the internal capsule. The *anterior end* points forwards and medialwards. It approaches its fellow of the opposite side and presents an elevation called the *anterior tubercle* which forms the posterior boundary of the interventricular foramen. The *posterior end* projects backwards and lateralwards. It diverges from its fellow of the opposite side and ends in a tubercle called the *pulvinar*. Beneath the pulvinar is a small pea-like oval swelling called the *medial geni-*

culate body which is connected with the inferior colliculus by the inferior brachium. Below and lateral to the pulvinar is another oval swelling called the *lateral geniculate body* which is connected with the superior colliculus by the superior brachium.

The **Pineal Body** (Figs. 139, 140) is a small conical, reddish body which is placed beneath the splenium of the corpus callosum and lies in the depression between the upper pair of corpora quadrigemina. It is covered by a fold of pia mater

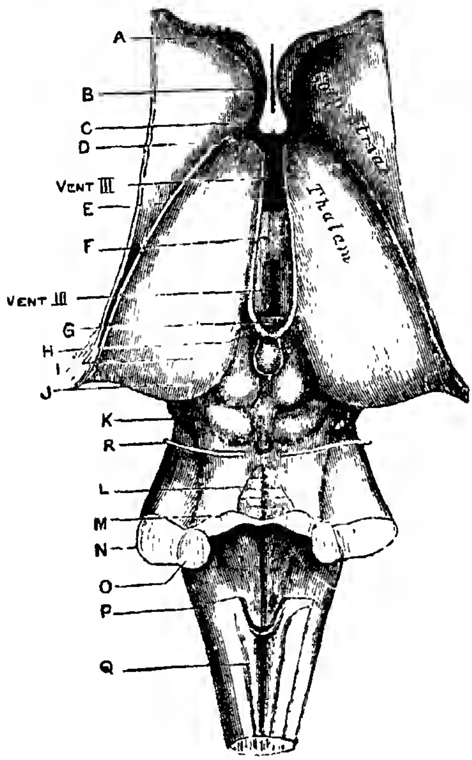

Fig. 140.—The medulla oblongata, mesencephalon and thalamencephalon (Cunningham).

A. Anterior cornu of lateral ventricle..
B. Septum pellucidum.
C. Column of fornix.
D. Interventricular foramen.
E. Stria terminalis.
F. Massa Intermedia.
G. Posterior commissure.
H. Stalk of the pineal body.
I. Pineal body.
J. Pulvinar.
K. Mesencephalon.
L. Lingula.
M. Brachium conjunctivum.
N. Brachium pontis.
O. Restiform body.
P. Medulla oblongata.
Q. Clava.
R. Trochlear nerve.

derived from the inferior layer of the tela chorioidea of the third ventricle. Its apex is directed backwards and its base which looks forwards is fixed by means of a stalk or peduncle. The *stalk* divides into a ventral and a dorsal part. The ventral part becomes continuous with a transverse band of white fibres lying underneath the pineal body called the posterior commissure. The dorsal part divides into two medullary striæ, each of which is prolonged on the thalamus of the corresponding side to be continuous with the tænia thalami. Between the ventral and dorsal parts of the stalk is a recess called the *pineal recess*.

The *posterior commissure* is a transverse band of white fibres which stretches across the upper end of the cerebral aqueduct. It lies behind the third ventricle and the pineal body lies over it. It is connected on either side with a nucleus in the central grey substance of the cerebral aqueduct, called the *nucleus of the posterior commissure*.

The *anterior commissure* is a rounded bundle of white fibres which lies transversely just in front of the columns of the fornix. It will be subsequently seen that its fibres can be traced downwards and backwards into the temporal lobe.

The **Third Ventricle** (Fig. 140) is the deep, narrow interval between the two thalami and reaches down to the base of the brain. It presents a roof, a floor, an anterior and a posterior boundary, and two lateral walls. Its *roof* is formed by the epithelial layer which lines the under surface of the tela chorioidea and the chorioid plexus of the third ventricle. Its *floor* is formed by certain parts found in the interpeduncular fossa at the base of the brain, viz., the tuber cinereum with the infundibulum, the corpora mamillaria, and the posterior perforated substance. Besides these structures the floor is formed more posteriorly by the tegmenta of the cerebral peduncles. The *anterior boundary* is formed by the lamina terminalis, the columns of the fornix and the anterior commissure. The *posterior boundary* is formed by the posterior commissure, the pineal body and the cerebral aqueduct. The *lateral wall* is formed above by the medial surface of the thalamus, and below, by a lamina of grey matter which passes upwards from the floor of the ventricle. The third ventricle communicates in front with the lateral ventricles through the interventricular foramina and behind with the fourth ventricle through the cerebral aqueduct, the opening

of which is seen just beneath the posterior commissure. A shallow groove, called the *hypothalamic sulcus*, extends along the lateral wall from the interventricular foramen to the opening of the cerebral aqueduct and indicates the lower limit of the medial surface of the thalamus. The ventricular cavity is crossed about its middle by the massa intermedia.

Recesses of the third ventricle.—Five recesses or small diverticula are seen in the third ventricle. In the anterior wall these are: the *optic recess* which lies above the optic chiasma and is situated at the junction of the anterior wall with the floor of the ventricle; and the *vulva* which lies above the anterior commissure. In the floor a funnel-shaped recess, called the *recessus infundibuli* is seen to project into the infundibulum. In the posterior wall there are two recesses: the *pineal recess* which passes into the stalk of the pineal body above the posterior commissure; and the *suprapineal recess* which lies above the pineal body —the wall of this diverticulum is formed by a prolongation of the epithelium of the roof of the ventricle.

The *trigonum habenulæ* is a triangular depression lying lateral to the posterior part of the pineal stalk and in front of the superior colliculus of the corpora quadrigemina. It contains a collection of nerve-cells called the *ganglion habenulæ.* Some fibres from this ganglion pass to the ganglion of the opposite side along the roof of the third ventricle. These fibres form what is called the *habenular commissure.*

THE MESENCEPHALON OR MID-BRAIN

The **Mid-Brain** connects the cerebral hemispheres above with the pons and cerebellum below. It consists of the cerebral peduncles lying ventrally, and four rounded bodies, called the corpora quadrigemina, lying dorsally. The whole of the mid-brain is traversed by a narrow tunnel, called the cerebral aqueduct.

The **Cerebral Peduncles** (crura cerebri) are two thick rope-like bundles composed chiefly of white fibres which emerge from the upper surface of the pons and diverge from each other to enter the inferior surface of the cerebral hemispheres. Each peduncle presents four surfaces. The ventral surface is crossed in front by the optic tract. The dorsal surface is surmounted by the corpora quadrigemina. The medial surface bounds the interpeduncular fossa and presents a groove, called the

oculomotor sulcus, from which the oculomotor nerve emerges. The lateral surface presents a groove called the *lateral sulcus* and is crossed in front by the optic tract and behind by the trochlear nerve. The sulci on the medial and lateral surfaces mark the subdivision of each peduncle into a ventral part called the *base* and a dorsal part called the *tegmentum*.

The **Corpora Quadrigemina** (Figs. 139, 140) are two pairs of rounded eminences composed of grey substance with a coating of white substance on the surface. They are situated on the dorsal aspect of the mid-brain. The upper pair, called the the *superior colliculi*, are oval in shape and larger than the lower pair, called the *inferior colliculi*, which are rounded. A cruciate groove separates the four eminences from each other. The longitudinal limb of the cruciate groove lies along the median line and ends above in a depression in which the pineal body lies. The lower end of the longitudinal limb terminates in a narrow white band, called the *frenulum veli*, which is continuous with a lamina called the anterior medullary velum. This lamina forms the upper part of the roof of the fourth ventricle. From each colliculus a white band, the *brachium*, passes upwards and forwards towards the geniculate bodies. The *superior brachium* passes upwards, forwards and lateralwards between the medial geniculate body and the pulvinar and divides into two parts; one of which enters the lateral geniculate body and the other is continuous with the optic tract. The *inferior brachium* passes upwards and forwards and ends beneath the medial geniculate body.

Optic Tracts.—The terminations (central connections) of the optic tracts may now be conveniently traced. These tracts have been traced from the optic chiasma to the lateral surfaces of the cerebral peduncles. Reaching the dorsal aspect of the lateral surface of the peduncle each tract divides into a medial and a lateral root. The *medial root* terminates in the medial geniculate body; it consists of fibres which connect the medial geniculate bodies of opposite sides and from what is termed the *commissure of Gudden*. The *lateral root* breaks up into three parts: one part ends in the pulvinar, the second in the lateral geniculate body, and the third reaches the superior colliculus through the superior brachium of the corpora quadrigemina.

Dissection. Divide the mid-brain transversely at the level of the lower border of the superior colliculi. On the cut surface the dissector will notice (1) the divided cerebral aqueduct,

(2) a mass of dark, pigmented grey substance called the substantia nigra, separating (3) the dorsal portion of the cerebral peduncle termed the tegmentum, from (4) its ventral part called the base.

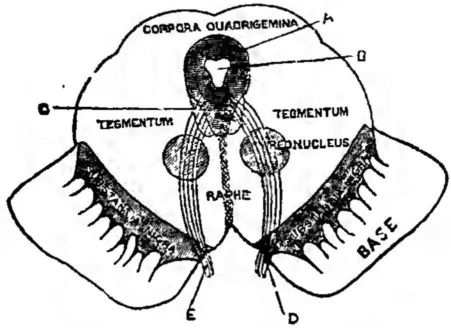

Fig. 141.—Diagram showing the cut surface of the mesencephalon when transversely divided (Cunningham).

A. Central grey stratum.
B. Cerebral aqueduct.
C. Median longitudinal fasciculus.
D. Sulcus oculomotorius.
E. Oculomotor nerve.

The **Cerebral Aqueduct** (Aqueduct of Sylvius) is a narrow canal, about half an inch in length, leading from the fourth to the third ventricle. It is placed nearer the dorsal than the ventral surface of the mid-brain. It is surrounded by a layer of grey substance called the *central grey stratum* in which are situated the nuclei of the oculomotor and trochlear nerves and the nucleus of the mesencephalic root of the trigeminal nerve. On transverse section the appearance of the aqueduct varies at different levels of the midbrain. Thus at the upper part it is triangular; in the middle part it is oval and in the lower part it is **T**-shaped.

The **Substantia Nigra** (Fig. 141) presents a crescentic outline on transverse section; it is a mass of deeply pigmented grey substance lying between the tegmentum and the base of the cerebral peduncle. It extends from the upper part of the pons to the subthalamic region. Its dorsal surface is concave and ventral surface convex. From the ventral surface processes project into the substance of the base of the peduncle. Its medial end is thick and lies against the oculomotor sulcus. Its lateral end lies against the lateral sulcus.

The **Base of the Peduncle** (crusta or pes) (Fig. 141) is semilunar on transverse section and is made up of longitudinal bundles

of white fibres. These bundles may be divided into three main parts. (1) The fibres occupying the lateral fifth of the base, and called the *temporo-pontine fibres*, begin from the temporal lobe of the hemisphere and end in the pons. (2) The fibres occupying the middle three-fifths of the base, called the *cerebrospinal fibres*, begin from the motor area of the cerebral cortex and proceed through the pons and the medulla oblongata, where some of the fibres end around the motor nuclei of the cerebral nerves. But most of the fibres are continued to the medulla spinalis. (3) The fibres occupying the medial fifth of the base, called the *frontopontine fibres*, begin from the frontal lobe and end in the pons.

The **Tegmentum** (Fig. 141) of one side is continuous with that of the opposite side in the median plane. It is composed of grey and white substance. The latter consists of longitudinal as well as transverse fibres The tegmentum thus forms a reticulated structure which is similar to the reticular formation of the medulla oblongata and the pons of which it is the upward prolongation. If a section is made through the mesencephalon of a fresh brain the student will see that most of the longitudinal fibres are arranged into well defined tracts, viz , (1) the medial longitudinal fasciculus, (2) the brachium conjunctivum, and (3) the lemniscus. In the grey substance the chief grey mass is formed by the red nucleus and the interpeduncular ganglion.

The *medial longitudinal fasciculus* is a small tract placed in the floor of the cerebral aqueduct on either side of the middle line. It consists of intersegmental fibres and is a prolongation upwards of the proper fasciculi of the anterior and lateral fasciculi of the medulla spinalis. These fibres end in a nucleus below the thalamus called the *nucleus of the medial longitudinal fasciculus.*

The *brachium conjunctivum* (superior cerebellar peduncle) issues from the cerebellum and passes upwards to the inferior colliculus beneath which it disappears. The brachia of the two sides are joined to each other at the lower part by a thin lamina, called the *anterior medullary velum*, with which they form the upper part of the roof of the fourth ventricle. As the brachium passes upwards it approaches its fellow of the opposite side. The fibres of the brachia then proceed taking a deeper course and decussate with each other. The decussated fibres end in the red nucleus and the thalamus.

The *lemniscus* (fillet) is a tract of longitudinal fibres which passes upwards through the ventral part of the tegmentum. It is divisible into two parts, medial and lateral, having different origins and terminations. The *medial lemniscus* consists of sensory fibres derived from the nucleus gracilis and nucleus cuneatus of the opposite side in the medulla oblongata. These are joined by fibres derived from the terminal nuclei of the cerebral nerves of the opposite side except those from the cochlear division of the acoustic nerve. Traced upwards they terminate in the thalamus. The *lateral lemniscus* is the lateral portion which is bent backwards from the medial portion and reaches the surface of the midbrain at the upper part of the lateral sulcus. This tract contains fibres derived from the nuclei of the cochlear division of the acoustic nerve and from the trapezoid and superior olivary nuclei; most of the fibres having connections with the opposite side. A collection of nerve cells, called the *nucleus of the lateral lemniscus*, is seen in the upper part of the lateral lemniscus. Here some of the fibres arborise and fresh fibres originate to continue in the path. They terminate in the inferior colliculus and median geniculate bodies by passing along the lateral aspect of the brachium conjunctivum.

Red Nucleus.—If the cerebral peduncle is divided through the superior colliculi a rounded, reddish grey mass will be seen. This is the red nucleus. It lies in the upper part of the tegmentum beneath the thalamus. Most of the fibres of the brachium conjunctivum terminate in it. Fibres descend from it to the lateral funiculus of the medulla spinalis of the opposite side as the *rubrospinal tract*. Above it is connected by fibres with the thalamus, corpus striatum, and frontal cortex. The nucleus is traversed by the emerging fibres of the root of the oculomotor nerve.

The *interpeduncular ganglion* is a small nucleus of grey substance in the ventral part of the tegmentum which is connected above with the habenular ganglion by a band of fibres called the *fasciculus retroflexus of Meynert*.

THE BASAL GANGLIA—INTERNAL AND EXTERNAL CAPSULES

Dissection. Separate the two hemispheres from each other by a sagittal incision exactly through the median plane. This incision should pass through the genu of the corpus callosum

and through the cavity of the septum pellucidum. The anterior commissure should be divided and the body of the fornix separated into two halves. The massa intermedia, the posterior commissure, the pineal body, the corpora quadrigemina and the aquæductus cerebri should be divided in the median line. At the base of the brain, the incision should pass through the centre of the optic chiasma, the tuber cinereum, between the corpora mamillaria and through the posterior perforated substance. From the remains of the right cerebral hemisphere remove a slice by a horizontal incision at the level of the interventricular foramen. On the surface of this section a bent tract of white substance, called the internal capsule, will be seen with the concavity turned lateralwards. In the concavity of the bend will be seen a biconvex lens-like, grey mass called the lentiform nucleus. On the medial side of the internal capsule, the sections of the caudate nucleus and the thalamus will be seen. On the lateral side of the lentiform nucleus another thin layer of white substance, called the external capsule, will be seen. Lateral to the external capsule a thin layer of grey substance, called the claustrum, will be noticed Lateral to the claustrum is the section of the insula with a lamina of white substance in the centre and convoluted grey substance on the surface. These parts should now be studied in detail.

The **Basal Ganglia** are the corpus striatum, the claustrum, and the amygdaloid nucleus (Fig. 142).

The **Corpus Striatum** is a large mass of grey substance situated in front of and to the lateral side of the thalamus. Part of it has been seen projecting into the lateral ventricle when this cavity was opened. This portion is called the intraventricular portion or the caudate nucleus, while the remaining portion of it is embedded in the white substance of the cerebral hemisphere and is called the extraventricular portion or lentiform nucleus.

The **Caudate Nucleus** is a pear-shaped mass of grey substance. It presents a broad anterior extremity or *head* which projects into the anterior cornu of the lateral ventricle ; and a narrow tapering posterior extremity or *tail* which lies on the lateral side of the thalamus and is prolonged downwards along the roof of the inferior cornu to terminate at the amygdaloid nucleus. It is separated in the greater part of its extent from the lentiform nucleus by a thick layer of white substance, the internal capsule, but is fused with that nucleus in front.

The **Lentiform Nucleus** as seen on the surface of the section, is a biconvex mass of grey substance. It is broader above than below. It is bounded laterally by a thin layer of white substance called the external capsule and medially by the internal capsule in the concavity of which it lies. It is continuous above and in front with the head of caudate nucleus and below with the anterior perforated substance. The substance of the lentiform nucleus is subdivided into three segments by two antero-posterior vertical laminæ of white substance called the *medullary laminæ*. Of these three segments the medial two are of a lighter colour being mixed up with white fibres and are together called the *globus pallidus*. The lateral segment is of a darker colour and is called the *putamen*.

The **Claustrum** is a thin lamina of grey substance lying between the external capsule medially and the white substance of the insula laterally. Its medial surface is concave. Its lateral surface is convex and irregular and adapted to the gyri and sulci of the insula. It is narrow above ; but broad below, where it is continuous with the anterior perforated substance and amygdaloid nucleus.

The *amygdaloid nucleus* has been already described (p. 421).

Nuclei of the Thalamus.—The student should now examine the surface of the section of the thalamus. He will note that the thalamus is bounded laterally by a thin white lamina called the *lateral medullary lamina*. The grey substance of the thalamus is subdivided into three nuclei by another white lamina called the *medial medullary lamina*. This lamina consists of a single stem behind and bifurcates in front thus subdividing the substance of the thalamus into three nuclei. The *anterior nucleus* is embraced by the bifurcating limbs of the medial lamina and includes the anterior tubercle and in it the thalamo-mamillary fasciculus ends. The *medial nucleus* is small and lies against the lateral wall of the third ventricle. The *lateral nucleus* is the largest and includes the posterior end of the thalamus. The stem of the medial lamina separates the medial from the lateral nucleus.

Connections of the Thalamus with the Cerebrum.—The thalamus is connected with the cerebral cortex by four stalks. These are (1) the anterior or *frontal stalk* which passes through the frontal part of the internal capsule to the cortex of the lobe ; (2) the *parietal stalk* which passes from the lateral surface of the thalamus to the parietal lobe ; (3) the inferior or

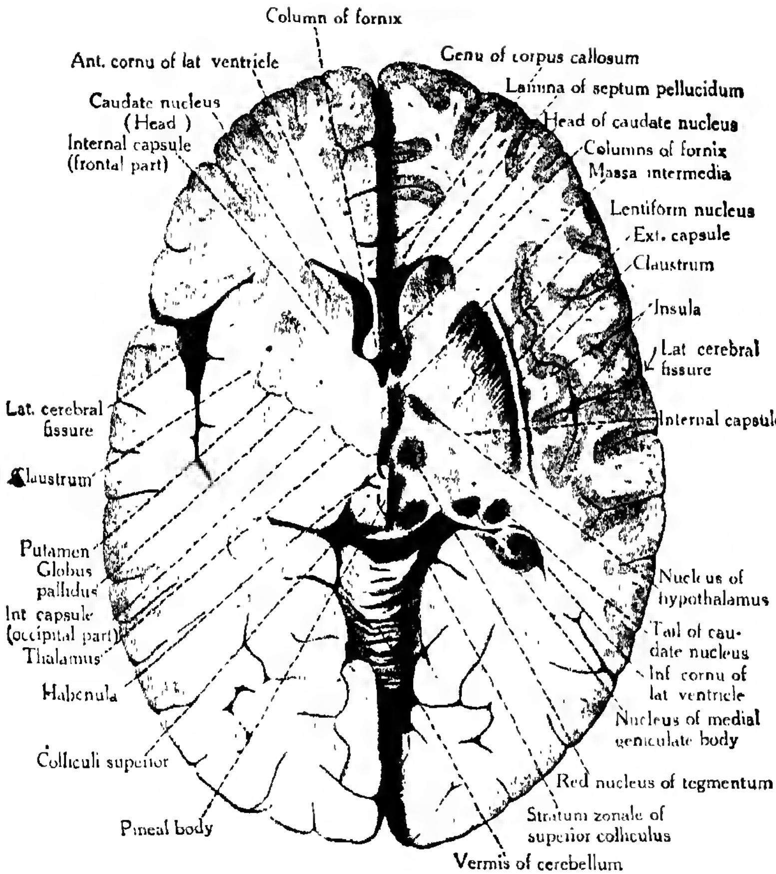

Fig. 142.—Horizontal section of the cerebral hemispheres through the basal ganglia and internal capsule (Sobotta).

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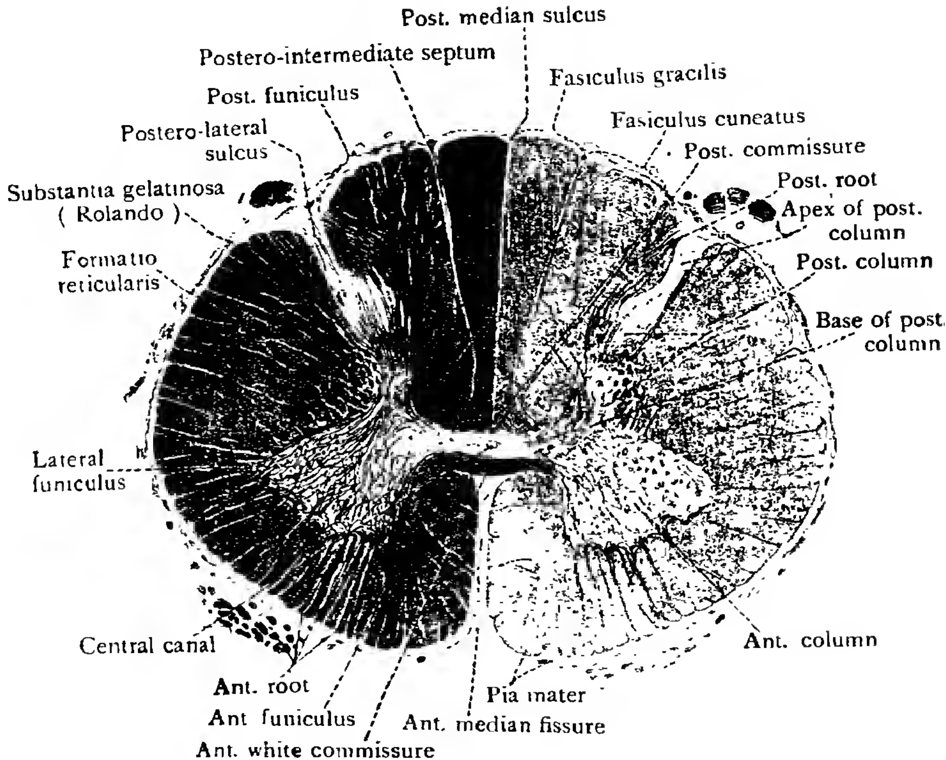


Fig. 143.—Transverse section of the medulla spinalis (Sobotta).

temporal stalk which passes from the medial and inferior surface of the thalamus beneath the lentiform nucleus to the temporal lobe and insula; (4) the posterior or *occipital stalk* (optic radiation) which passes from the posterior end of the thalamus through the occipital part of the internal capsule to the occipital lobe.

Substantia innominata of Meynert.—This is the name given to the layer of grey and white substance lying beneath the anterior part of the thalamus and the lentiform nucleus. It consists of three layers from above downwards. (1) The *superior layer* or *ansa lentiformis* is derived from the medullary laminæ of the lentiform nucleus and passes to the inferior surface of the thalamus. The *middle layer* is formed by fibres derived from the parietal lobe and the medial longitudinal fasciculus. The *inferior layer* is formed by the inferior or temporal stalk of the thalamus.

Dissection. Take the remains of the left cerebral hemisphere and break off the gyri of the insula and gradually proceed medialwards till the external capsule is removed and the lateral surface of the lentiform nucleus is exposed. Define the continuity of the lentiform and caudate nuclei anteriorly. When the lentiform nucleus has been well defined try to isolate it from the internal capsule lying medially. In suitably hardened specimens the lentiform and caudate nuclei and the thalamus can be, if care is taken, isolated from the internal capsule. If another cerebral hemisphere is available an attempt should be made to show the continuity of the internal capsule through the corpus callosum to the cerebral cortex. The gyri are to be broken off with the fingers and the radiating fibres of the internal capsule (corona radiata) to the cortex of the brain are to be defined. While this is being done some bundles of long association fibres will be seen connecting the distant gyri of different lobes. Note the *superior longitudinal fasciculus* above the lentiform nucleus which passes backwards from the frontal lobe in front to the occipital lobe behind. The *inferior longitudinal fasciculus* connects the temporal and occipital lobes passing along the lateral wall of the inferior cornu of the lateral ventricle. The *uncinate fasciculus* connects the frontal lobe with the anterior end of the temporal lobe along the bottom of the lateral cerebral fissure.

The **Internal Capsule** is a broad band composed of white fibres, lying between the lentiform nucleus laterally and the

caudate nucleus and thalamus medially. It establishes very important connections of the cerebral cortex with the basal ganglia, the nuclei of the cerebral nerves below, and the medulla spinalis. In horizontal section it presents a bend, called the *genu*, the convexity of which projects between the caudate nucleus and the thalamus. The part in front of the genu is called the frontal part; the part behind the genu i. called the occipital part of the internal capsule. The *frontal part* of the internal capsule contains: (1) fibres passing upwards from the thalamus to the frontal lobe; (2) fibres connecting the lentiform and caudate nuclei; (3) fibres passing from the corpus striatum to the cortex; and (4) fronto-pontine fibres, which pass from the frontal lobe through the medial fifth of the base of the cerebral peduncle to the pons. The genu contains fibres which arise from the motor area of the cerebral cortex and are called the *geniculate fibres*; these fibres pass through the base of the cerebral peduncle and terminate in the motor nuclei of the cerebral nerves of the opposite side. The anterior two-thirds of the *occipital part* of the internal capsule contain cerebro-spinal fibres which originate from the motor area of the cerebral cortex and occupy together with the geniculate fibres the middle three-fifths of the base of the cerebral peduncle; these fibres are then continued through the pons into the pyramids of the medulla oblongata. The posterior third of the occipital part of the internal capsule contains: (1) sensory fibres from the thalamus and some sensory fibres direct from the medial lemniscus; (2) fibres of optic radiation from the lower visual centres (the pulvinar, lateral geniculate body and superior colliculus) to the cortex of the occipital lobe; (3) fibres of acoustic radiation from the medial geniculate body and inferior colliculus to the cortex of the temporal lobe. If the fibres of the internal capsule are traced upwards they are seen to diverge and radiate to all parts of the cortex of the brain forming the *corona radiata*. The fibres of the frontal part of the internal capsule are chiefly connected with the cortex of the frontal lobe; those of the genu and the anterior two-thirds of the occipital part, with the motor area of the cortex; those of the posterior third of the occipital part, with the parietal, temporal, and occipital regions of the cortex. Traced below the fibres of the internal capsule are continuous with the base of the cerebral peduncle.

The **External Capsule** is a thin lamina of white substance situated between the lentiform nucleus medially and the claus-

trum laterally. It is continuous in front, behind and above with the internal capsule.

The columns of the fornix should now be traced to their terminations in the corpora mamillaria by removing the ependyma covering them in the lateral walls of the third ventricle. Each column passes downwards and backwards and terminates in the mamillary body at the base of the brain. On trying to detach the mamillary body a bundle of white fibres called the *thalamomamillary fasciculus* (bundle of Vicq d'Azyr) will be seen passing upwards and backwards to the anterior part of the thalamus.

Dissection. The anterior commissure should now be traced to its termination. Trace it from the cut end following the direction of its fibres and breaking through the brain substance with the handle of the scalpel. Note that the fibres pass beneath the caudate nucleus and can be traced with care to the temporal lobe.

The *anterior commissure* is a rounded bundle of white fibres; it connects the temporal lobes of the two sides It has been seen to form the anterior boundary of the third ventricle and to lie in front of the columns of the fornix Thence it passes on either side lateralwards, backwards and downwards and enters the temporal lobe across the bottom of the lateral cerebral fissure

MEDULLA SPINALIS

The medulla spinalis which was put in preserving fluid should now be studied so that the continuity of its parts with those of the medulla oblongata may be examined.

The **Attachments of Spinal Nerve-Roots** have already been described (p. 242).

Fissures and Sulci.—The *antero-median fissure* lies vertically along the median line on the anterior surface. The *postero-median sulcus* lies vertically on the posterior surface of the medulla spinalis along the median line. It is very shallow and from its bottom a septum of neuroglia tissue, called the postero-median septum, passes into the substance of the medulla spinalis. Another groove, called the *posterolateral sulcus*, lies on either side of the posteromedian sulcus and gives attachment to the fila of the posterior nerve-roots along a continuous straight line.

Regions of the Medulla Spinalis.—By these three sulci

the surface of each half of the medulla spinalis is divided into two regions: (1) the *anterolateral region* which lies between the anteromedian fissure and the posterolateral sulcus and

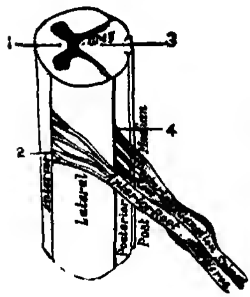


Fig. 144.—Sideview of the medulla spinalis (Gray).

Grey.—Grey substance.
Anterior.—Anterior funiculus.
Lateral.—Lateral funiculus.
Posterior.—Posterolateral funiculus.
Post-median.—Posteromedian funiculus.
1. Anteromedian fissure.
2. Attachment of anterior root.
3. Posteromedian fissure.
4. Posterolateral fissure.

gives attachment to the fila of the anterior nerve roots—these fila are attached not in a straight line but irregularly, extending over an area of some width; (2) the *posterior funiculus* which lies between the posteromedian and posterolateral sulci Each of these regions is again subdivided into two parts. Thus the anterolateral region is subdivided into an *anterior funiculus* and a *lateral funiculus*—the two being separated by the line of attachment of the most lateral fila of the anterior nerve-roots. The posterior funiculus is subdivided by a faint groove called the *postero-intermediate sulcus*, into the posteromedian funiculus (column of Gall) which lies between the posteromedian and postero-intermediate sulci and the *posterolateral funiculus* (column of Burdach) which lies between the postero-intermediate and posterolateral sulci. It should be noted that the postero-intermediate sulcus which lies between the posteromedian and posterolateral sulci can be traced only in the cervical and thoracic regions.

Directions. Make a thin transverse section of the medulla spinalis, place it on a glass slide and hold it on to the light. From this section the structure of the medulla spinalis can be to a great extent studied with the naked eye.

Internal Structure of the Medulla Spinalis (Fig. 143).—The medulla spinalis consists of white nervous substance externally and grey substance internally.

Grey substance.—In a transverse section the grey substance presents the appearance of two comma-shaped masses the convexities of which are directed towards each other. These

are connected together by a transverse band of grey substance called the *grey commissure.* These masses together with the transverse grey commissure present the shape of the letter **H**. Through the grey commissure a minute canal, called the *central canal,* runs throughout the entire length of the medulla spinalis. Below, the canal is continued for a short distance into the filum terminale ; above, it traverses the lower part of the medulla oblongata and opens into the fourth ventricle of the brain. In the lower part of the conus medullaris it presents a fusiform dilatation called the *terminal ventricle.* In the cervical and thoracic segments of the medulla spinalis the central canal is nearer to its anterior surface. In the lumbar enlargement the canal is in the centre whereas in the conus medullaris it is nearer the posterior surface of the medulla spinalis. The central canal is surrounded by a stratum of gelatinous substance called the *substantia gelatinosa centralis.* The portion of the grey commissure lying in front of the central canal is called the *anterior grey commissure* and that behind it is called the *posterior grey commissure.* The posteromedian septum reaches the posterior grey commissure but the bottom of anteromedian fissure is separated from the anterior grey commissure by a band of white substance called the *anterior white commissure.*

Each comma shaped mass of grey substance is divisible into an anterior column lying in front of the grey commissure and a posterior column lying behind it. The *anterior grey column* (anterior cornu) is short, thick and rounded and is separated from the surface of the spinal medulla by white substance through which the fila of the anterior nerve-roots pass to the surface. Its enlarged extremity is called the *head* and the posterior constricted portion is called the *base.* In sections of the thoracic segment of the medulla spinalis another triangular projection is seen projecting lateralwards from the base of the anterior column. This projection is called the *lateral column.* The *posterior column* (posterior cornu) is long and narrow ; it presents a slight enlargement near the posterolateral sulcus called the *head.* The head tapers to a pointed extremity called the *apex* with which the fila of the posterior nerve roots are continuous. In front of the head is a slight constriction called the *neck* and in front of the neck is the *base* which is continuous with the base of the anterior column. Surrounding the apex of the posterior grey column is a translucent mass of cells called the *substantia gelatinosa of Rolando.* The variations in the shape and size

of the grey substance in different regions of the medulla spinalis should be noted, by making thin transverse sections therefrom. Thus if a thin transverse section is taken from the cervical region of the medulla spinalis where the cervical nerves are attached, the grey substance of the anterior column is seen to be much enlarged and the posterior column though enlarged is thinner than the anterior. In the thoracic segment of the medulla spinalis corresponding to the attachments of the thoracic nerves both the anterior and posterior columns are much attenuated. The presence of the lateral column in the thoracic segment has been already referred to. In the lumbar segment of the medulla spinalis corresponding to the attachments of the lumbar nerves both the columns of grey substance are enlarged—specially the posterior one so that the difference between the anterior and posterior columns are less distinct. In the conus medullaris corresponding to the attachments of the sacral nerves the grey substance assumes an oval shape on either side connected together by broad grey commissure.

The **white substance** of the medulla spinalis is subdivided into three funiculi : anterior, lateral, and posterior, corresponding to the three regions on the surface In the *anterior funiculus* there is an important fasciculus called the *fasciculus cerebro-spinalis anterior* (direct pyramidal tract) which lies on either side of the anteromedian fissure. In the *lateral funiculus* there are four important fasciculi : (1) the *fasciculus spinocerebellaris* (direct cerebellar tract) which lies superficially at the back part of the lateral funiculus ; (2) the *superficial anterolateral fasciculus* (tract of Gowers) which also lies superficially in front of the former fasciculus ; (3) the *fasciculus cerebrospinalis lateralis* (crossed pyramidal tract) which lies between the fasciculus spino-cerebellaris and the posterior grey column ; (4) the *rubrospinal fasciculus* (Monakow's bundle) which lies in front of the lateral cerebrospinal fasciculus and has a triangular appearance on transverse section. These fasciculi cannot be identified with the naked eye. In the upper cervical region the fila of the spinal nerve roots of the accessory nerve pass through the lateral funiculus. In the *posterior funiculus* there are two fasciculi : (1) the *fasciculus gracilis* (Goll's tract) which lies posteromedially, and (2) the *fasciculus cuneatus* (Burdach's tract) which lies posterolaterally. These two fasciculi can be identified in thin sections with the naked eye. They are separated from each other by the postero-intermediate sulcus.

HIND-BRAIN

The hind brain (Rhombencephalon) lies below the tentorium cerebelli and occupies the posterior cranial fossa. It consists of the medulla oblongata, the pons, and the cerebellum including the fourth ventricle and the isthmus rhombencephali.

The **Medulla Oblongata** (Figs. 130, 145) extends from the lower margin of the pons to the level of the lower margin of the foramen magnum : at this level it becomes continuous with the medulla spinalis.It is a little more than an inch in length, three fourths of an inch wide at its broadest part, and half an inch in thickness. Its anterior surface rests in the groove on the basilar portion of the occipital bone. Its posterior surface lies in the fossa between the hemispheres of the cerebellum and forms the lower part of the floor of the fourth ventricle. Its lateral surfaces are in relation with the vertebral artery. The anteromedian and posteromedian fissures of the spinal medulla are continued into the medulla oblongata. These fissures indicate that the medulla oblongata is divided into two symmetrical halves.

Fissures on the surface of the medulla oblongata.—The *anteromedian fissure* is interrupted at its lower part by some bundles of fibres crossing from one side to the other. This intercrossing of fibres is called the *pyramidal decussation.* Above the decussating fibres, some fibres issue from this fissure and proceed lateralwards over the surface of the medulla oblongata ; these are called the *external arcuate fibres.* This fissure ends above at the lower border of the pons in a cul-de-sac called the *foramen cæcum.* The *posteromedian fissure* is continued upwards to about the middle of the medulla oblongata and ceases at the lower end of the fourth ventricle. The attachment of the roots of the hypoglossal nerve along a continuous straight line marks the position of a faint groove called the *anterolateral sulcus* ; this line of attachment is continuous with the line of the anterior roots of the medulla spinalis. The attachments of the roots of the glossopharyngeal, vagus, and accessory nerves in a line indicate the position of another faint groove called the *posterolateral sulcus* ; this line is continuous with the line of the posterior roots of the medulla spinalis.

Regions of the medulla oblongata.—Advantage is taken of these two rows of nerve-roots to subdivide the surface of each half of the medulla oblongata into three regions ; anterior, posterior and lateral.

The **Anterior Region** or **Pyramid** constitutes that portion of the medulla oblongata which is included between the anteromedian fissure and the anterolateral sulcus. It is narrow below but it expands as it passes upwards and again becomes constricted at the lower border of the pons and enters into that structure. At the lower part the fibres of the medial two-thirds of each pyramid cross to the opposite side forming the *pyramidal decussation*. These fibres after crossing the middle line proceed downwards in the posterior part of the lateral funiculus of the medulla spinalis as the lateral cerebrospinal fasciculus. The pyramidal decussation can be easily verified by inserting the handle of the scalpel into the anteromedian fissure below the decussation and separating the lateral margins of the fissure. The remaining lateral third of the pyramid is continued down into the anterior funiculus of the medulla spinalis on the same side as the anterior cerebrospinal fasciculus.

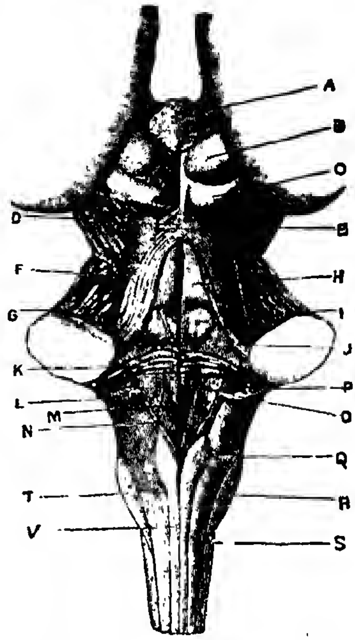
The **Lateral Region** is situated between the anterolateral sulcus containing the roots of the hypoglossal nerve and the posterolateral sulcus containing the roots of the glossopharyngeal, vagus, and accessory nerves. In the lower part of the medulla oblongata it appears as a continuation of the lateral funiculus of the spinal medulla ; but in its upper part, it lies hidden by a conspicuous oval-shaped eminence called the *olive.* Behind the olive and between it and the posterolateral sulcus is seen an attenuated continuation upwards of the lateral region. The olive is about half an inch in length and is separated from the lower border of the pons by a groove where the facial nerve is attached. In as much as the lateral cerebro-spinal fasciculus passes into the pyramid of the opposite side and the direct cerebellar tract joins the restiform body, it follows therefore that a very small portion of the lateral funiculus of the medulla spinalis is prolonged upwards into the lateral region of the medulla oblongata. This narrow strand passes upwards between the olive and the posterolateral sulcus. Some arched fibres, called the *external arcuate fibres*, emerge from the antero-median fissure curve backwards over the pyramid and olive and enter the restiform body.

The **Posterior Region** is included between the postero-median fissure and the posterolateral sulcus. At its lower part it is subdivided into three smaller funiculi by slight furrows. The medial funiculus is close to the posteromedian fissure and is called the *fasciculus gracilis ;* it terminates in the lower part of the fourth

ventricle in an expanded elevation called the *clava* beneath which is a nucleus of grey matter called the ***nucleus gracilis.*** Lateral

Fig. 145.—Dissection of the fourth ventricle of the brain (Cunningham).

A. Pineal body.
B. Superior colliculus.
C. Inferior colliculus.
D. Anterior medullary velum.
E. Cerebral peduncle.
F. Brachium conjunctivum.
G. Brachium pontis.
H. Pontine part of floor of fourth ventricle.
I. Colliculus facialis.
J. Fovea superior.
K. Stria medullaris.
L. Area acustica.
M. Fovea inferior.
N. Ala cinerea.
O. Trigonum hypoglossi.
P. Restiform body.
Q. Clava.
R. Tuberculum cinereum.
S. Fasciculus cuneatus.
T. Cuneate tubercle.
V. Fasciculus gracilis.



to the fasciculus gracilis is the *fasciculus cuneatus*; it also ends in the lower part of the fourth ventricle in an elevation, called the *cuneate tubercle,* which overlies a nucleus of grey matter called the *nucleus cuneatus.* These two fasciculi are the continuations of the same strands in the posterior funiculus of the medulla spinalis. Lateral to the fasciculus cuneatus is the *fasciculus of Rolando* which is narrow below and ends above in an elevation, the *tuberculum cinereum.* It is caused by the substantia gelatinosa of Rolando and is covered on the surface by the spinal tract of the trigeminal nerve. There is no corresponding part of the fasciculus of Rolando in the posterior funiculus of the medulla spinalis. At the upper part of the medulla oblongata the posterior region is occupied by two thick rope-like strands called the *restiform bodies.* Each restiform body lies between the lower part of the fourth ventricle and the roots of the glossopharyngeal and vagus nerves. It passes upwards and lateralwards diverging from its fellow of the opposite side and forms the lower part of the lateral boundary of the fourth ventricle. It then turns backwards and enters the corresponding cerebellar

hemisphere and constitutes the *inferior peduncle of the cerebellum.* The restiform body appears on superficial observation to be formed by the continuation upwards of the fasciculus gracilis and fasciculus cuneatus. But in reality the gracilis and cuneate fasciculi terminate in their respective nuclei already referred to. The restiform body is chiefly formed by (1) the fibres of the cerebello-spinal fasciculus (direct cerebellar tract) which pass upwards from the lateral funiculus of the spinal medulla; (2) the external arcuate fibres which enter them by curving backwards over the olive; (3) olivo-cerebellar fibres from the inferior olivary nucleus.

The **Pons** (Pons Varolii) (Fig. 130) is the connecting link between the cerebrum above, the medulla oblongata below and the cerebellum behind. At its upper part are seen the cerebral peduncles while its lower part is continuous with the medulla oblongata. Its *ventral* or *anterior surface* is convex and consists of transverse fibres; these are gathered together on each side into a compact mass, which enters the cerebellum and is termed the *brachium pontis* (middle peduncle of the cerebellum). The trigeminal nerve is attached to this surface near its upper border and demarcates the brachium pontis which lies lateral to this attachment. This surface rests on the clivus of the sphenoid and presents a shallow median groove, *sulcus basilaris,* along which the basilar artery runs. The *dorsal* or *posterior surface* forms the upper part of the floor of the fourth ventricle and will be subsequently described.

The **Cerebellum** is situated behind the medulla oblongata and the pons and beneath the occipital lobes of the cerebrum. It is covered externally by grey substance which is darker than that of the cerebrum. The white substance occupies its interior. Its surface is not mapped out by tortuous convolutions like those of the cerebrum, but it consists of a large number of thin laminæ which are separated by numerous parallel curved sulci.

The cerebellum consists of two lateral parts called the *hemispheres* and a median part called the *vermis.* The part of the vermis which lies on the upper surface of the cerebellum is called the *superior vermis;* and the part on the lower surface, the *inferior vermis,* which is lodged in a deep median fossa between the hemispheres called the *vallecula cerebelli.* The hemispheres are separated below and behind by a deep notch, called the *posterior cerebellar notch,* into which the falx cerebelli is received. Above and in front they are separated by a broad and shallow notch,

called the *anterior cerebellar notch*, which receives the inferior colliculi and brachia conjunctiva cerebelli.

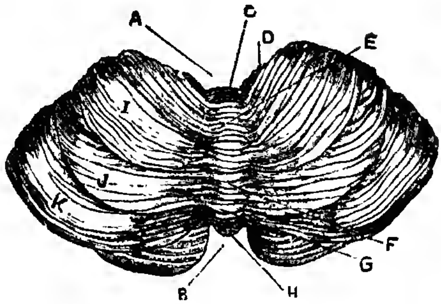


Fig. 146.—Superior surface of the cerebellum.

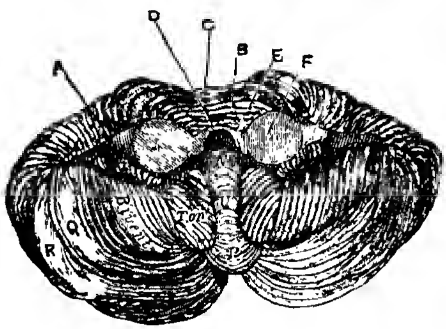
A. Anterior cerebellar notch.
B. Posterior cerebellar notch.
C. Lobulus centralis.
D. Ala lobuli centralis.
E. Culmen monticuli.
F. Clivus monticuli.
G. Folium vermis.
H. Tuber vermis.
I. Anterior part of quadrangular lobe.
J. Posterior part of quadrangular lobe.
K. Superior semilunar lobule.

Superior Surface of the Cerebellum.—The fissures and lobules on the superior vermis are continuous with those on the superior surface of the hemispheres. The fissures have the same names both on the vermis and the hemispheres, but the lobules are differently named. Thus on the superior vermis there are five lobules. Commencing from the front these are: the lingula, the central lobule, the culmen monticuli, the clivus monticuli, and the folium vermis. The lingula has no corresponding lobule on the superior surface of the cerebellar hemisphere. The remaining four lobules of the superior vermis have corresponding lobules on the hemispheres. These are from before backwards; the ala lobulus centralis, the anterior crescentic lobule, the posterior crescentic lobule, and the superior semilunar lobule. The *lingula* consists of four or five folia prolonged upwards from the vermis on to the surface of the anterior medullary velum. The *lobulus centralis* is separated from the lingula by the *precentral fissure* and is continuous laterally with the ala lobulus centralis. The *culmen monticuli* is the most prominent part of the superior vermis. It is separated from the lobulus centralis by the *postcentral fissure*. Laterally it is continuous with the anterior crescentic lobule on the hemisphere. The *clivus monticuli* is on the slope of the monticulus and is separated from

the culmen by the *preclival fissure* which is prolonged laterally on the hemisphere behind the anterior crescentic lobule. Laterally the clivus is continuous with the posterior crescentic lobule. The culmen and clivus are together called the monticulus. The anterior and posterior crescentic lobules are included under one name, the quadrangular lobule. The *folium vermis* (folium cacuminis) is the posterior end of the superior vermis separated from the clivus by the postclival fissure. Laterally it is continuous with the superior semilunar lobule on the hemisphere.

The *horizontal sulcus* is the most conspicuous fissure in the cerebellum. It begins in front at the pons, and passing backwards round the lateral and posterior borders of each hemisphere, dips down into the posterior cerebellar notch. It divides the cerebellum into an upper and a lower part demarcating the inferior surface.

Inferior Surface of the Cerebellum.—Both the inferior vermis and the inferior surface of the cerebellar hemispheres are subdivided into lobules by fissures. But the continuity of the lobules of the inferior vermis with those on the inferior surface of the hemispheres is not so marked as on the superior surface. The lobules on the inferior vermis from before backwards are: (1) the nodule, (2) the uvula, (3) the pyramid, and (4) the tuber vermis. The lobules on the inferior surface of the hemisphere are: (1) the flocculus, (2) the tonsilla cerebelli, (3) the biventer



147.—Inferior surface of the cerebellum.

A. Flocculus.
B. Ala lobuli centralis.
C. Lobulus centralis.
D. Anterior medullary velum.
E. Brachium conjunctivum.
F. Brachium pontis.
N. Nodule.
P. Pyramid.
Q. } Inferior semilunar lobule.
R. }
U. Uvula.

lobule, and (4) the inferior semilunar lobule. The fissures separating the lobules of the inferior vermis are (1) the *postnodular fissure* which separates the nodule from the uvula. It passes lateralwards into the hemisphere separating the flocculus in front from the tonsilla and biventral lobule behind and joins the anterior end of the horizontal sulcus. (2) The *prepyramidal fissure* separates the uvula from the pyramid on the inferior vermis; in the hemisphere it curves forwards round the tonsilla between it and the biventral lobe to join the postnodular fissure in front. (3) The *postpyramidal fissure* separates the pyramid from the tuber vermis and passes lateralwards behind the tonsilla and biventral lobule and in front of the inferior semilunar lobule to join the horizontal sulcus. The *nodule* is connected with the flocculus laterally by a thin layer of white substance which emerges from the cerebellum and is called the *posterior medullary velum*. The *flocculus* lies against the brachium pontis. These three parts, viz., the nodule, the posterior medullary velum, and the flocculus constitute the *lobus noduli*. The *uvula* is connected with the tonsilla on either side by a narrow ridge of grey substance marked with furrows on the surface, called the *furrowed band*. The uvula, the furrowed band, and the tonsilla constitute the *lobus uvulæ*. The *pyramid* is connected on either side with the biventral lobule by a grey band which lies across the sulcus vallecula. The pyramid, the grey band, and the biventral lobule constitute the *lobus pyramidalis*. The *tuber vermis* is continuous directly with the inferior semilunar lobule; the two lobules are included under one name, the *lobus tuberis*.

Structure of the Cerebellum.—Make a sagittal section through the right cerebellar hemisphere close to the vermis. The cerebellum will then be seen to consist of a central core of white substance with a superficial covering of grey substance. The central core of white substance is seen to give off thin laminated branches into the interior of the individual folia or laminæ which are provided with superficial coating of grey substance. These radiating white branches from the central core of white substance present the appearance of a branching tree. This characteristic appearance is called the *arbor vitæ cerebelli*. In the central core of white substance a folded lamina of grey substance is found called the *dentate nucleus*. Its wall has a wavy outline. Its open mouth or hilum is directed forwards and medialwards through which white fibres of the brachium conjunctivum pass. Its opposite end is blind. In addition to the dentate nucleus

there are other minute nuclei of grey substance imbedded in the white substance. Thus there are two nuclei medial to the hilum of the dentate nucleus, called the *nucleus emboliformis* and the *nucleus globosus*. A third nucleus is seen over the roof of the fourth ventricle close to the middle line and is called the *nucleus fastigii*. These nuclei cannot be easily demonstrated with the naked eye.

Dissection. Make a sagittal section through the superior vermis exactly in the median line. The roof of the fourth ventricle is thus divided. On separating the cerebellar hemispheres the floor of the fourth ventricle is exposed.

Connections of the Cerebellum.—The cerebellum is connected with the cerebrum, the pons, and the medulla oblongata by three bundles of fibres on each side. These are the brachium conjunctivum, the brachium pontis, and the restiform body.

The *brachium conjunctivum* (superior cerebellar peduncle) emerges from the upper part of the cerebellum and lies medial to the brachium pontis. It forms at first the upper and lateral boundary of the fourth ventricle. Higher up it approaches its fellow of the opposite side and forms the upper part of the roof of the same ventricle. Its further course has been described (p. 431). Most of the fibres of the brachium conjunctivum are derived from the dentate nucleus. The triangular interval between the two brachia conjunctiva is filled up by the anterior medullary velum.

The *brachium pontis* (middle cerebellar peduncle) consists of transverse fibres of the pons which enter the cerebellar hemisphere through the anterior part of the horizontal sulcus and lie lateral to the other two peduncles. It is the largest of the three peduncles.

The *restiform body* (inferior cerebellar peduncle) enters the cerebellum between the brachium conjunctivum and the brachium pontis. Its formation has been described (p. 443). Before it enters the cerebellum it is crossed dorsally by strands of white fibres called the *striæ medullares*.

Two other thin laminæ of white substance which emerge from the central core of the cerebellum and assist in forming the roof of the fourth ventricle are now to be examined. They are the anteiror and posteiror medullary vela.

The *anterior medullary velum* (valve of Vieussens) is the triangular lamina of white substance which issues from the white central core of the cerebellum and fills up the gap between the

two brachia conjunctiva. It forms the roof of the fourth ventricle and on its dorsal surface lies the lingula of the superior vermis.

The *posterior medullary velum* is a thin lamina of white substance which also emerges from the white central core of the cerebellum in close contact with the anterior medullary velum. The two vela then diverge; the anterior velum passes upwards and the posterior velum, downwards round the nodule of the inferior vermis. The posterior velum ends below in a thin crescentic margin which is free, but as a matter of fact it is continuous with the epithelial lining of the ventricle.

Isthmus rhombencephali.—This name is given to the constricted part of the rhombencephalon which lies between the corpora quadrigemina above and the cerebellum below. It is formed laterally by the brachia conjunctiva, dorsally by the anterior medullary velum, and ventrally by the upper part of the pons. It contains the upper part of the fourth ventricle.

The **Fourth Ventricle** (Fig. 145) is situated behind the pons and the upper part of medulla oblongata. It presents for examination two lateral boundaries, four angles, a roof, and a floor.

Each *lateral boundary* is formed below by the clava, the fasciculus cuneatus and the restiform body; above, by the brachium pontis and the brachium conjunctivum.

Angles.—The *superior angle* corresponds to the convergence of the brachia conjunctiva and leads into the cerebral aqueduct. The *inferior angle* corresponds with the lower end of the olive and leads into the central canal of the medulla oblongata. The *lateral angles* correspond with the junctions of the upper lateral and lower lateral boundaries. Below the lateral angle, the fourth ventricle is prolonged laterally, on either side, over the upper part of the restiform body as a recess called the *lateral recess.*

The *roof* or dorsal wall of the fourth ventricle is formed above by the brachia conjunctiva and the anterior medullary velum; below, by the posterior medullary velum, the tela chorioidea of the fourth ventricle lined by ventricular epithelium, the obex, and the tænia of the fourth ventricle. Of these the posterior medullary velum has been described and may now be more fully examined.

The *tela chorioidea of the fourth ventricle* is a triangular layer of pia mater lined by the ventricular epithelium. It forms

the roof of the fourth ventricle below the posterior medullary velum. Above, the tela is continuous with the pia mater on the lower surface of the vermis; laterally, it is continued over the lateral recess; below, it is continuous with the pia mater on the restiform body. The *chorioid plexuses of the fourth ventricle* are vascular fringes of the tela chorioidea which project into the ventricular cavity from the roof by pushing the epithelial covering before it. Each plexus presents a vertical and a horizontal limb; the vertical limb lies close to the middle line; the horizontal limb passes lateralwards to the end of the lateral recess—it joins its fellow of the opposite side in the middle line. There are three openings in the tela chorioidea by means of which the cavity of the fourth ventricle communicates with the subarachnoidean cavity. One of these, the *apertura medialis* (foramen of Magendie), is situated over the inferior angle of the ventricle. The other two, called the *apertura laterales* (foramina of Key and Retzius,), lie over the ends of the lateral recesses. The *obex* is a thin triangular lamina of grey substance which bridges over the inferior angle of the fourth ventricle from the clava of one side to the other. The *tæniæ of the fourth ventricle* (ligulæ) are two narrow bands of white substance seen, one on either side of the lower part of the roof of the fourth ventricle. The medial margin of each tænia is continuous with the epithelial lining of the tela chorioidea; its lateral margin is attached to the clava and runs transversely across the restiform body below the stria medullaris. Below it is continuous with the obex. It forms the inferolateral limit of the roof of the fourth ventricle.

The *floor* or anterior wall of the fourth ventricle is called the *rhomboid fossa* from its shape. It is lozenge-shaped and is formed by the dorsal surface of the pons above and the dorsal surface of the upper part of the medulla oblongata below. It is bisected by a vertical median groove, called the *median sulcus*; this sulcus extends from the superior to the inferior angle of the fossa and is shallow above but deep below. On either side of this sulcus is an elongated elevation called the *medial eminence* which is limited laterally by a sulcus called the *sulcus limitans*. The rhomboid fossa is traversed at its widest part opposite the lateral recesses by some transverse white fibres, called the *striæ medullares* (striæ acusticæ), which belong to the cochlear division of the acoustic nerve. Medially these white strands sink into the median sulcus; laterally they cross the upper part of the restiform bodies. By these striæ the rhomboid fossa is

subdivided into an upper and a lower part. In the upper part of the fossa the elevation of the medial eminence occupies the whole width of the corresponding half of the floor of the fossa. Just above the striæ medullares the medial elevation presents a nodular elevation, called the *colliculus facialis*, which is caused by the underlying ascending portion of the root of the facial nerve. In the lower part of the rhomboid fossa and below the colliculus the medial eminence becomes narrow and triangular and is called the *trigonum hypoglossi* as it overlies the nucleus of the hypoglossal nerve The sulcus limitans presents in its upper part a narrow slate coloured area called the *locus cæruleus*, which owes its colour to pigmented cells, called the *substantia ferruginea*, lying underneath. Lateral to the colliculus facialis the sulcus limitans widens into a shallow fossa called the *superior fovea* ; lateral to the trigonum hypoglossi it becomes distinctly deep and is called the *inferior fovea*. Lateral to the superior and inferior foveæ is another triangular elevation called the *area acustica* which extends to the lateral recess and is crossed superficially by the striæ medullares. Below the inferior fovea and between the trigonum hypoglossi and the area acustica is a triangular area darker in colour than the rest of the fovea and called the *ala cinerea* (trigonum vagi). This area corresponds to the sensory nuclei of the glossopharyngeal and vagus nerves. Below the ala cinerea is a ridge-like elevation, called the *funiculus separans*, which separates the ala from a small area on the lower part of the floor called the *area postrema*. The inferior angle of the rhomboid fossa is pointed and from its resemblance to a pen is called the *calamus scriptorius*.

Dissection. On the left side the student should try to trace the restiform body and the brachia pontis and conjunctivum through the cerebellum to investigate their ultimate destination. The laminæ of the hemispheres should be broken and the direction of the fibrous strands followed. The brachium conjunctivum can be traced to the dentate nucleus while the brachium pontis and the restiform body will be seen to spread out into the cerebellar cortex.

Remove the cerebellum by dividing the brachia and the restiform bodies. The continuity of the pyramid with the cerebrospinal fasciculus in the base of the cerebral peduncle should be traced through the pons. Divide the superficial transverse fibres of the pons along the middle line and reflect them laterally till a longitudinal bundle is reached in continuity with the

pyramid. This is the *cerebrospinal fasciculus.* Note that this fasciculus occupies the middle three-fifths of the base of the cerebral peduncle, and is continued through the pons producing a longitudinal bulging on either side of the sulcus basilaris. While passing through the pons some of the fibres of the cerebrospinal fasciculus end by arborising around the motor nuclei of the cerebral nerves of the opposite side. The remaining fibres of the fasciculus appear in the medulla oblongata as the pyramid. Remove the cerebrospinal fasciculus. The deep transverse fibres of the pons are seen lying dorsally to the fasciculus. These form the *trapezoid body.* Covering the upper part of the pyramid and the olive some curved transverse fibres are seen. These are the *external arcuate fibres.*

If the deep transverse fibres of the pons are removed another bundle of longitudinal fibres will be seen on either side of the middle line. This is the *lemniscus.* It contains fibres from the superficial anterolateral fasciculus of the medulla spinalis and the internal arcuate fibres from the nuclei gracilis and cuneatus of the opposite side. These fibres are reinforced in their course by afferent fibres derived from the terminal nuclei of the sensory cerebral nerves of the opposite side. In the medulla oblongata it passes dorsal to the pyramid. In the pons it lies dorsal to the trapezoid body. Its position in the mid-brain as a medial and a lateral lemniscus has been examined.

Directions. The medulla oblongata should now be divided at different levels. Its structure can be fully studied from stained microscopic sections. But if a thin section is placed on a glass slide and held on to the light some of the structures described can be identified with the naked eye.

In sections through the olive, the olivary nucleus will be seen. It resembles to some extent the dentate nucleus of the cerebellum being formed by a folded lamina of grey substance with wavy outline. The median raphe with decussation of fibres may be made out.

In sections through the gracilis and cuneate nuclei these nuclei will appear as dark condensed spots.

Structure of the Medulla Oblongata.—It consists of grey nuclei and white fibres. The grey nuclei of the medulla oblongata connected with the cerebral nerves are the following :—(1) Nucleus of the hypoglossal nerve. (2) Nucleus ambiguus which is the combined motor nucleus of the glossopharyngeal, vagus and accessory (cerebral portion) nerves. (3) The tractus solitarius

which is the terminal nucleus of the facial, glossopharyngeal and vagus nerves. (4) Portion of the nuclei of the acoustic nerve. (5) The terminal nucleus of the spinal tract of the trigeminal nerve. There are other nuclei in the medulla oblongata not connected with the cerebral nerves. These are: (1) the nucleus gracilis, where the fasciculus gracilis terminates; (2) the nucleus cuneatus, where the fasciculus cuneatus terminates; (3) the inferior olivary nucleus seen inside the olive; (4) the medial accessory olivary nucleus lying medial to the ventral end of the hilum of the inferior olivary nucleus; (5) the dorsal accessory olivary nucleus lying dorsal to the hilum of the same nucleus; (6) the nucleus arcuatus lying under cover of the external arcuate fibres; (7) the two nuclei of reticular formation situated in its lateral part—the nucleus of Roller and nucleus lateralis.

White fibres of the Medulla Oblongata.—The fasciculi on the surface including the pyramid have been fully described. The *formatio reticularis* inside the medulla oblongata requires special consideration. This name is given to the reticulum that is formed in the medulla oblongata by the interlacing of longitudinal and transverse fibres. It occupies a position dorsal to the pyramid and olive and is subdivided into an anterior and a lateral part. The anterior part is also called the *formatio reticularis alba* as it is not intermingled with grey nuclei. The longitudinal fibres in this part are: (1) the internal arcuate fibres from the nucleus gracilis and nucleus cuneatus; (2) tecto-spinal fibres which come from the superior colliculus; and (3) the median longitudinal fasciculus which is the continuation upwards of the fasciculus proper of the medulla spinalis. The lateral portion of the formatio reticularis is called the *formatio reticularis grisea* for it contains two nuclei of grey substance, viz., nucleus of Roller and nucleus lateralis and extends laterally to the restiform bodies. The longitudinal fibres in the lateral part are derived mainly from (1) the superficial anterolateral fasciculus of medulla spinalis and (2) the rubro-spinal fasciculus. The transverse fibres in both parts of the reticular formation are the external arcuate fibres.

Reference has already been made of the internal and external arcuate fibres. Their origin, course and termination should now be studied in detail.

The *internal arcuate fibres* arise from the nucleus gracilis and nucleus cuneatus in the medulla oblongata. They pass forwards through the neck of the posterior column of the grey substance

and cross the middle line forming what is called the *sensory decussation* or *decussation of the lemniscus*. Then the fibres ascend as a flattened band called the *lemniscus* or *fillet*.

The *external arcuate fibres* also arise from the nucleus gracilis and nucleus cuneatus. They pass forwards and decussate in the middle line forming the transverse fibres of the formatio reticularis. Then they emerge mostly through the anteromedian fissure of the medulla oblongata and curve lateralwards and backwards round the surface of the pyramid and olive and enter the restiform body. A small grey nucleus is formed where the fibres cover the pyramid. This is called the external arcuate nucleus. Some of the external arcuate fibres emerge between the pyramid and olive to join the main bundle.

Structure of the Pons.—It consists of grey substance and white fibres.

Grey substance of the pons.—The nuclei in connection with the cerebral nerves are: (1) the nucleus of the facial nerve, (2) the nucleus of the abducent nerve, (3) the sensory and motor nuclei of the trigeminal nerve, (4) part of the nucleus of the acoustic nerve. The other nuclei in the pons are: (1) Nuclei pontis—these are scattered between the transverse fibres of the pons. (2) The trapezoid nucleus in the trapezoid body, seen in connection with the cochlear fibres of the acoustic nerve. (3) The superior olivary nucleus situated dorsal to the trapezoid body and also connected with cochlear fibres.

White fibres of the pons.—The main transverse and longitudinal bundles have been already described. The reticular formation of the medulla oblongata is continued through the pons to the midbrain.

TABLE OF THE ARTERIES OF THE HEAD AND NECK

1. Right common carotid
   1. External carotid
      1. Superior thyroid
         1. Hyoid
         2. Sternocleidomastoid
         3. Superior laryngeal
         4. Cricothyroid
         5. Terminal
      2. Lingual
         1. Hyoid
         2. Dorsalis linguæ
         3. Sublingual
         4. Profunda linguæ
      3. External maxillary
         1. Ascending palatine
         2. Tonsillar
         3. Glandular
         4. Submental
         5. Inferior labial
         6. Superior labial
         7. Muscular
         8. Lateral nasal
         9. Angular
      4. Occipital
         1. Sternocleidomastoid
         2. Mastoid
         3. Auricular
         4. Muscular
         5. Descending branch
         6. Meningeal
         7. Occipital
      5. Posterior auricular
         1. Muscular
         2. Stylomastoid
         3. Auricular
         4. Occipital
      6. Ascending pharyngeal
         1. Pharyngeal
         2. Inferior tympanic
         3. Posterior meningeal
      7. Superficial temporal
         1. Parotid
         2. Articular
         3. Transverse facial
         4. Anterior auricular
         5. Zygomatico-orbital
         6. Middle temporal
         7. Frontal
         8. Parietal
      8. Internal maxillary
         - 1st part
           1. Deep auricular
           2. Anterior tympanic
           3. Middle meningeal
           4. Accessory meningeal
           5. Inferior alveolar
         - 2nd part
           6. Deep temporal
           7. Pterygoid
           8. Masseteric
           9. Buccinator
         - 3rd part
           10. Posterior superior alveolar
           11. Infraorbital
           12. Descending palatine
           13. Artery of pterygoid canal
           14. Pharyngeal
           15. Sphenopalatine
   2. Internal carotid .. .. .. See p. 456

- **Internal carotid**
  - From petrous portion:
    1. Caroticotympanic
    2. Pterygoid
  - From cavernous portion:
    3. Cavernous
    4. Hypophysial
    5. Semilunar
    6. Anterior meningeal
    7. Ophthalmic ..
       1. Central artery of retina
       2. Lacrimal
       3. Muscular
       4. Short posterior ciliary
       5. Long posterior ciliary
       6. Supraorbital
       7. Posterior ethmoidal
       8. Anterior ethmoidal
       9. Anterior meningeal
       10. Medial palpebral
       11. Frontal
       12. Dorsal nasal
  - From cerebral portion:
    8. Anterior cerebral ..
    9. Middle cerebral ..
    10. Posterior communicating ..
    11. Anterior chorioidal ..

- **Arch of Aorta gives off**
  1. Innominate
     1. Right common carotid .. See p. 455
     2. Right subclavian
        1. Vertebral
           - Cervical:
             1. Spinal
             2. Muscular
           - Cranial:
             3. Meningeal
             4. Posterior spinal
             5. Anterior spinal
             6. Posterior inferior cerebellar
             7. Medullary
        2. Internal mammary .. See Table of Thorax
        3. Thyreo-cervical trunk
           1. Inferior thyreoid .
              1. Muscular
              2. Ascending cervical
              3. Inferior laryngeal
              4. Tracheal
              5. Oesophageal
              6. Glandular
           2. Transverse scapular ..
              1. Suprasternal
              2. Acromial
              3. Muscular
              4. Nutrient
              5. Articular
           3. Transverse cervical
              - Ascending
              - Descending
        4. Costocervical .. See Table of Thorax
     3. Thyreoidea ima (occasional)
  2. Left common carotid .. Same as of Right common carotid
  3. Left subclavian .. Same as of Right subclavian

TABLE OF THE VEINS OF THE HEAD AND NECK

INNOMINATE VEIN is joined by

- 1. Internal jugular receives
  - 1. Transverse sinus ..
    - 1. Superior sagittal sinus (on right side)
    - 2. Straight sinus (on left side) ..
      - 1. Inferior sagittal sinus
      - 2. Great cerebral vein
      - 3. Superior cerebellar veins
    - 3. Occipital sinus
    - 4. Inferior cerebral and inferior cerebellar veins
    - 5. Superior petrosal sinus
  - 2. Inferior petrosal sinus ..
    - (5 and 2) Cavernous sinus receives
      - 1. Sphenoparietal sinus
      - 2. Superior ophthalmic vein
      - 3. A branch of inferior ophthalmic vein
      - 4. Middle cerebral vein
      - 5. Inferior cerebral veins
  - 3. Common facial
    - Anterior facial ..
    - Anterior branch of posterior facial ..
  - 4. Lingual
  - 5. Pharyngeal
  - 6. Superior thyreoid
  - 7. Middle thyreoid
  - 8. Occipital (occasionally)
- 2. Subclavian receives
  - 1. *External jugular* ..
    - 1. Posterior branch of posterior facial vein
    - 2. Posterior auricular vein
    - 3. Posterior external jugular
    - 4. Transverse cervical
    - 5. Transverse scapular
    - 6. Anterior jugular
    - 7. A branch from internal jugular
    - 8. Occipital (occasionally)
  - 2. *Thoracic duct (left side)*
  - 3. Right lymphatic duct (right side)
- 3. Vertebral
- 4. Internal mammary
- 5. Inferior thyreoid
- 6. First intercostal vein (occasionally)
- 7. Superior intercostal vein (of left innominate vein only)

EMISSARY VEINS

	Connects	Through
1. Frontal	Veins of nose with superior sagittal sinus	Foramen cæcum
2. Parietal	Occipital veins with superior sagittal sinus	Parietal foramen
3. Mastoid	Posterior auricular or occipital vein with transverse sinus	Mastoid foramen
4. Condyloid	Veins in suboccipital triangle with transverse sinus	Condyloid foramen
5. Plexus of hypoglossal canal	Internal jugular vein with transverse sinus	Hypoglossal canal
6. Plexus of foramen ovale	Pterygoid plexus with cavernous sinus	Foramen ovale
7. Vein of foramen Vesalii	Pterygoid plexus with cavernous sinus	Foramen Vesalii
8. Veins of the foramen lacerum	Pterygoid plexus with cavernous sinus	Foramen lacerum
9. Internal carotid plexus of veins	Internal jugular vein with cavernous sinus	

DIPLOIC VEINS

	Opens into
1. Frontal diploic vein	Supraorbital vein
2. Anterior temporal diploic vein	Sphenoparietal sinus or anterior deep temporal vien
3. Posterior temporal diploic vein	Transverse sinus
. Occipital diploic vein	Transverse sinus or occipital vein

TABLE OF THE CEREBRAL NERVES

1. Olfactory .. .. To olfactory region of nasal cavity
2. Optic nerve .. .. To retina through bulb of the eye
3. Oculomotor nerve
   - Superior ramus ..
     1. To levator palpebrae
     2. To rectus superior
   - Inferior ramus
     1. To rectus medialis
     2. To rectus inferior
     3. *To obliquus inferior* .. *Short or parasympathetic root of ciliary ganglion*
4. Trochlear nerve — To obliquus superior oculi
5. Trigeminal nerve
   1. Ophthalmic
      1. Lacrimal
      2. Frontal ..
         1. Supratrochlear
         2. Supraorbital
      3. Nasociliary
         1. *Long or sensory root of ciliary ganglion*
         2. *Long ciliary*
         3. Infratrochlear
         4. Posterior ethmoidal
         5. Anterior ethmoidal ..
            - Internal nasal
            - External nasal
   2. Maxillary ..
      1. Middle meningeal .. .. In cranium
      2. *Zygomatic* — *Zygomatico temporal*; *Zygomatico facial* — *In pterygopalatine fossa*
      3. Sphenopalatine .. .. — *In pterygopalatine fossa*
      4. Posterior superior alveolar .. — *In pterygopalatine fossa*
      5. Middle superior alveolar .. — In infraorbital canal
      6. Anterior superior alveolar .. — In infraorbital canal
      7. Inferior palpebral . .. — On face
      8. External nasal .. . — On face
      9. Superior labial .. . — On face
   3. Mandibular
      1. Nervus spinosus
      2. Nerve to pterygoideus internus
      3. Anterior trunk ..
         1. Masseteric
         2. Deep temporal
         3. *Buccinator*
         4. Nerve to pterygoideus externus
      4. Posterior trunk ..
         1. Auriculo-temporal ..
            1. Communicating
            2. Anterior auricular
            3. To external acoustic meatus
            4. Auricular
            5. Parotid
            6. Superficial temporal
         2. Lingual
         3. Inferior alveolar ..
            1. Mylohyoid
            2. Dental
            3. Incisive
            4. Mental
6. Abducent nerve .. .. .. To rectus lateralis oculi

TABLE OF THE CEREBRAL NERVES—(Continued)

7. **Facial nerve**
   - Communicates with
     1. Acoustic nerve
     2. Sphenopalatine ganglion
     3. Otic ganglion
     4. Sympathetic plexus on middle meningeal artery
     5. Auricular branch of vagus
     6. Glossopharyngeal and vagus
     7. Great auricular, auriculotemporal, lesser occipital and cutaneous cervical
     8. Trigeminal
   - Gives off
     1. To stapedius
     2. Chorda tympani
     3. Posterior auricular
     4. Digastric
     5. Stylohyoid
     6. Temporal
     7. Zygomatic
     8. Buccal
     9. Mandibular
     10. Cervical

8. **Acoustic nerve**
   - Vestibular division
     1. To semicircular ducts
     2. To utricle
     3. To saccule
   - Cochlear division — To cochlea

9. **Glossopharyngeal nerve**
   - 1 Communicates with
     1. Facial
     2. Vagus
     3. Sympathetic trunk
   - Gives off
     1. Tympanic
     2. Carotid
     3. Pharyngeal
     4. To stylopharyngeus
     5. Tonsillar
     6. Lingual

10. **Vagus nerve**
    - 10. Communicates with
      1. Glossopharyngeal
      2. Facial
      3. Accessory
      4. Hypoglossal
      5. Sympathetic
      6. 1st and 2nd cervical
    - Gives off
      - In jugular fossa:
        1. Meningeal
        2. Auricular
      - In neck:
        3. Pharyngeal
        4. Superior laryngeal
        5. Right recurrent
        6. Superior cardiac
      - In thorax:
        7. Inferior cardiac
        8. Left recurrent
        9. Anterior bronchial
        10. Posterior bronchial
        11. Oesophageal
      - In abdomen:
        12. Gastric
        13. Coeliac
        14. Hepatic

11. **Accessory nerve**
    - Cerebral part — To vagus
    - Spinal part
      - Gives off — To sternocleidomastoideus; To trapezius
      - Communicates with — 2nd, 3rd, and 4th cervical nerves.

12. **Hypoglossal nerve**
    - Gives off
      1. Meningeal
      2. Descending
      3. Thyreohyoid
      4. Muscular to muscles of tongue
    - Communicates with
      1. Sympathetic trunk
      2. Vagus
      3. 1st and 2nd and cervical
      4. Lingual

13. **Nervus terminalis** — to mucous membrane of nose

GANGLIA ASSOCIATED WITH CEREBRAL NERVES

1. **Ciliary ganglion** ..
   - Roots ..
     - Sensory, from nasociliary nerve
     - Parasympathetic, from the branch of the oculomotor nerve to the inferior oblique muscle
     - Sympathetic, from cavernous plexus of sympathetic
   - Branches .. Short ciliary nerves

2. **Sphenopalatine ganglion** .
   - Roots ..
     - Sensory, from two sphenopalatine branches of maxillary nerve
     - Parasymathetic, from nerve of pterygoid canal through greater superficial petrosal of facial
     - Sympathetic, from nerve of pterygoid canal through deep petrosal of internal carotid plexus
   - Branches
     1. Orbital
     2. Palatine .. ..
        - Anterior
        - Middle
        - Posterior
     3. Posterior superior nasal
     4. Pharyngeal

3. **Otic ganglion** ..
   - Roots ..
     - Motor, from nerve to pterygoideus internus
     - Sensory, from glossopharyngeal } Through lesser superficial petrosal
     - Parasympathetic, from facial } Through lesser superficial petrosal
     - Sympathetic, from sympathetic plexus on middle meningeal artery
   - Branches ..
     1. Sphenoidal to nerve of pterygoid canal
     2. To chorda tympani
     3. To auriculotemporal
     4. To tensor tympani
     5. To tensor veli palatini

4. **Submaxillary ganglion** ..
   - Roots ..
     - Sensory from lingual
     - Parasympathetic from chorda tympani
     - Sympathetic from plexus on external maxillary artery
   - Branches to ..
     - Submaxillary gland
     - Sublingual gland
     - Mucous membrane of mouth

TABLE OF THE SPINAL NERVES OF THE HEAD NECK.

Cervical nerves divide into

- Anterior Divisions
  - The upper four form the *cervical plexus* which gives off
    1. Smaller occipital (from 2 C.)
    2. Great auricular (from 2, 3 C.
    3. Cutaneous cervical from 2, 3 C.)
    4. Supraclavicular (from 3, 4C.)
    5. Muscular to rectus capitis lateralis, rectus capitis anterior, longus colli, longus capitis, sternocleidomastoid, trapezius, levator scapulae, scalenus medius
    6. Communicantes cervicales
    7. Communicating to vagus, accessory, hypoglossal, sympathetic
    8. Phrenic
  - The lower four cervical and greater part of the first thoracic together with a filament from 4th C N form the *brachial plexus* which gives off
    - Supraclavicular branches
      1. To phrenic nerve (from 5 C.)
      2. Dorsal scapular (from 5 C.)
      3. Suprascapular (from 5, 6 C.)
      4. To subclavius (from 5, 6 C.)
      5. Long thoracic (from 5, 6, 7, C.)
      6. To scaleni and longus colli (from 5, 6, 7, 8 C.)
    - Infraclavicular branches
      - See Table of Superior Extremity
- Posterior Divisions (Except of 1 C. N.)
  - Medial
  - Lateral

TABLE OF THE SYMPATHETIC SYSTEM IN THE HEAD AND NECK.

SYMPATHETIC TRUNK

- A. CEPHALIC PORTION .. begins as .. Internal carotid nerve .. Gives off ..
  - Medial branch .. forms cavernous plexus
  - Lateral branch .. forms internal carotid plexus
- B. CERVICAL PORTION .
  - 1. Superior cervical ganglion gives off
    - Lateral ..
      - 1. Grey rami communicantes to upper four cervical nerves
      - 2. Communicating branches to glossopharyngeal, vagus and hypoglossal
    - Medial ..
      - 1 Laryngopharyngeal .. forms pharyngeal plexus
      - 2. Superior cardiac
    - Anterior
      - Form plexuses upon common carotid artery and external carotid artery and its branches
  - 2. Middle cervical ganglion gives off
    - 1. Grey rami communicantes to fifth and sixth cervical nerves
    - 2. Thyreoid
    - 3. Middle cardiac
  - 3. Inferior cervical ganglion gives off
    - 1. Grey rami communicantes to seventh and and eighth cervical nerves
    - 2. Inferior cardiac
    - 3. Plexuses upon subclavian artery and its branches
  - 4. Intervening portions of the trunk

THE SUPERIOR EXTREMITY

THE BACK

This dissection includes chiefly an examination of the structures connecting the upper limb to the posterior aspect of the trunk and should be finished in two days. The dissector of the superior extremity begins work on the fourth day after the subject has been brought into the dissecting-room and during the first two days he should work in conjunction with the dissector of the head and neck ; the latter will work at the cervical region while the former will work at other regions lower down (see Table on p. 220). The subject is now placed with the face downwards and the arms extended over the sides of the table. Blocks are placed beneath the chest and pelvis.

Surface Anatomy.—The student should first find out the prominent projection of the spine of the seventh cervical vertebra in the middle line at the lower end of the neck. The spines of the first two thoracic vertebræ below that projection can be easily found. Below these spines a furrow along the middle line of the back will be seen. This furrow is produced by the prominence on either side of the middle line of the longitudinal muscles of the back. This furrow disappears at the back of the sacrum at about its middle. The spines of the vertebræ can be felt as the finger is carried down the furrow. The uneven posterior surface of the sacrum and the coccyx should then be felt. Above the prominence of the buttocks is the crest of the ilium and its highest point is on a level with the spine of the fourth lumbar vertebra. Above this the spine of the third lumbar vertebra can be located.This spinous process is important being on a level with the lower end of the kidney. The different parts of the scapula should be made out, specially, its inferior angle, the crest of the spine and the acromion. The twelfth rib can be felt by deep pressure as it forms the lowest boundary of the thoracic cavity on either side of the vertebral column.

Dissection. The dissector of the superior extremity reflects the skin from the back of the thoracic, lumbar, sacral and coccygeal regions by the following incisions (Fig. 71) :—(1) A vertical incision from the spinous process of the seventh cervical vertebra along the middle line to the tip of the coccyx ; (2) from the lower end of this vertical incision a curved incision upwards,

forwards and lateralwards along the crest of the ilium to a point a little behind the anterior superior iliac spine; (3) a third incision from the spinous process of the twelfth thoracic vertebra upwards, forwards, and lateralwards to the tip of the acromion. Reflect the two flaps of skin lateralwards.

The **Superficial Fascia** is thick and fatty and is a portion of the superficial fascia covering the whole body. In it ramify the cutaneous vessels and nerves. It is separated from the muscles underneath by a dense fibrous layer which constitutes the **deep fascia**. The latter is continuous with the deep fasciæ of the neighbouring regions.

Dissection. To find out the cutaneous nerves the student should first ascertain the direction in which they run from the diagram (Fig. 72). In well-injected subjects the cutaneous arteries which accompany these nerves serve as guides. He should cut through the superficial fascia along the direction of these cutaneous nerves and trace them to their points of exit from the deep fascia. After these have been studied, he should proceed with the dissection of the trapezius which has been described on p. 221.

The **Cutaneous Vessels** and **Nerves** have been fully described (p. 233 et seq.).

The muscles connecting the upper limb to the posterior aspect of the back are five in number. Of these the trapezius and latissimus dorsi form the superficial stratum; the levator scapulæ and the two rhomboids are situated beneath the trapezius.

The **Trapezius** has been fully described (p. 221).

Dissection. In dissecting the latissimus dorsi the student should carefully note that (1) the upper portion of the muscle near the spines of the thoracic vertebræ lies under cover of the trapezius while the remaining portion is superficial; (2) the upper margin of the muscle near the arm contributes to the formation of the posterior fold of the axilla; (3) the muscle is attached to the posterior lamella of the lumbodorsal fascia over the lumbar region; (4) the lower margin of the muscle is attached to the crest of the ilium; (5) the slips of origin of the muscle from the lower three or four ribs interdigitate with the slips of the obliquus externus abdominis; (6) a fleshy slip usually arises from the inferior angle of the scapula and joins the deep surface of the muscle.

The **Latissimus Dorsi** is a wide, flat, triangular muscle which covers the lower half of the thoracic and the whole of lumbar

region. It arises (1) from the spinous processes and supraspinous ligaments of the lower six thoracic vertebræ ; (2) from the posterior lamella of the lumbodorsal fascia—by means of this origin it is attached to the spines of the lumbar and sacral vertebræ and the corresponding supraspinous ligaments and to the back part of the crest of the ilium ; (3) from the outer lip of the iliac crest a little behind the origin of the obliquus externus abdominis by fleshy fibres in continuity with the lumbodorsal fascia behind ; (4) from the outer surfaces of the lower three or four ribs interdigitating with the origin of the obliquus externus abdominis ; and (5) from the dorsal surface of the inferior angle of the scapula. The upper fibres pass horizontally lateralwards ; the intermediate ones obliquely upwards and lateralwards ; and the lower fibres almost vertically upwards. All the fibres ultimately converge to form a narrow flat tendon which turns round the lower border of the teres major and passes in front of the tendon of that muscle. The insertion of the flat tendon into the floor of the intertubercular sulcus of the humerus will be seen later on. It is supplied by the thoracodorsal nerve. *Actions*.—The latissimus dorsi adducts the arm and also draws it backwards ; it rotates the arm inwards. When the arms are fixed it helps in pulling the trunk forwards as in climbing.

The *trigonum lumbale* (Petit's triangle) is a triangular interval bounded in front by the posterior border of the obliquus externus abdominis, behind by the lateral border of the latissimus dorsi, and below by the crest of the ilium which forms its base. The apex is formed by the meeting of the two muscles above. The floor of the triangle is formed by the obliquus internus abdominis. This triangular space is a weak spot in the abdominal wall. Another triangular space is bounded laterally by the vertebral border of the scapula, below by the latissimus dorsi, and above by the trapezius. The floor of this triangle is formed by the rhomboideus major and a very small portion of the sixth intercostal space which is subcutaneous. This triangle has been named the *triangle of auscultation*.

Reflect the trapezius laterally and note the accessory nerve and branches from the third and fourth cervical nerves which lie beneath the muscle and enter its deep surface (p. 222). The levator scapulæ, the origin of the inferior belly of the omohyoideus, the transverse scapular artery, the suprascapular nerve, and the transverse cervical artery—all these, which the

dissector of the superior extremity has to examine at this stage in conjunction with the dissector of the head and neck have been described on p. 222 et seq. The rhomboid muscles should next be cleaned and studied.

The **Rhomboideus Minor** (Fig. 73) arises (1) from the lower part of the ligamentum nuchæ, and (2) from the spinous processes of the seventh cervical and first thoracic vertebræ. It is inserted into the base of the smooth triangular surface at the root of the spine of the scapula.

The **Rhomboideus Major** (Fig. 73) arises from the spinous processes of the thoracic vertebræ, from the second to the fifth inclusive, and (2) from the corresponding supraspinous ligaments. It is inserted into a tendinous arch attached to the vertebral border of the scapula extending from the inferior angle of the scapula to the insertion of the rhomboideus minor.

The rhomboid muscles are supplied by the dorsal scapular nerve which enters their deep surfaces. They draw the scapula upwards and backwards.

Dissection. Divide the rhomboidei midway between their origin and insertion and reflect them medially and laterally. If the levator scapulæ has been examined by the dissector of the head and neck it should be divided at its middle and the lower part reflected downwards. While reflecting the muscle one or two twigs from the dorsal scapular nerve will be seen to enter the levator scapulæ The dorsal scapular nerve and the descending branch of the transverse cervical artery are now exposed.

The *dorsal scapular nerve* arises from the brachial plexus (p. 260). It passes beneath the levator scapulæ (to which it gives a twig) in company with the descending branch of the transverse cervical artery and enters the deep surfaces of the rhomboid muscles.

The *descending branch of the transverse cervical artery* (posterior scapular artery) passes under cover of the levator scapulæ (p. 222). In then descends along the vertebral border of the scapula under cover of the rhomboidei and reaches the inferior angle. It supplies the subscapularis, trapezius, latissimus dorsi and rhomboid muscles and anastomoses with branches of the transverse scapular and subscapular arteries in the subscapular fossa and supra- and infraspinous fossæ.

Dissection. The latissimus dorsi should now be reflected. Divide the muscle by a vertical incision. commencing from its

superior border midway between the spines of the vertebræ and inferior angle of the scapula. When the incision is continued downwards, take care that the knife is carried behind the costal origin of the muscle. Reflect the two portions medially and laterally. In raising the medial portion care must be taken not to injure the thin serratus posterior inferior which lies over the lower four ribs. Lastly, display the termination of the thoraco-dorsal nerve in the muscle.

Directions. The dissector of the superior extremity now stops work till the subject is put upon its back. The dissection of the back is completed by the dissector of the head and neck (see Table on p. 220).

THE PECTORAL REGION AND AXILLARY SPACE

Directions. Devote four days to the dissection of these regions. The subject should be placed upon its back and the thorax raised to a convenient height by blocks. A long wooden board is to be put under the shoulder to support the upper limbs which are to be stretched out at right angles to the chest.

Surface Anatomy.—The student should feel for himself the following bony landmarks before the skin is reflected:—The whole of the clavicle, the tip of the coracoid process(felt about an inch below the junction of the lateral and middle thirds of the clavicle under cover of the anterior fibres of the deltoideus), the acromion, the jugular notch, and the sternal angle (at the junction of the manubrium and body of the sternum).

Dissection. The following *incisions* (Fig. 4) should be made :—(1) A vertical incision along the median line from the centre of the jugular notch to the tip of the xiphoid process ; (2) from the upper end of the first incision lateralwards along the clavicle to the tip of the acromion ; (3) from the lower end of the first incision horizontally lateralwards along the side of the body ; (4) from the tip of the xiphoid process upwards and lateralwards along the anterior fold of the axilla to its junction with the arm. The flaps of integument thus marked out are to be reflected—flap 5 towards the arm and flap 6 towards the side of the thorax (Fig. 4) ; but the skin of the nipple and its areola is to be left intact.

The **Superficial Fascia** is fatty and in it will be seen the mamma and the cutaneous vessels and nerves. As the

superficial fascia passes upwards over the clavicle a thin layer of muscle fibres will be seen in its deeper part. This constitutes the lower part of the platysma.

Dissection. Make a vertical incision over the superficial fascia along the middle line of the sternum. The cut should reach the level of the deep fascia. The superficial fascia is now to be raised and separated from the deep fascia and reflected. laterally. When the margin of the sternum is reached look for the anterior cutaneous nerves in the intercostal spaces. They are accompanied by minute arteries which serve as guides in well-injected bodies. Both are to be traced laterally to their terminations. The supraclavicular nerves are then to be sought along the upper border of the clavicle ; the middle supraclavicular nerves usually dividing into two filaments will be found over the middle of the clavicle ; the posterior supraclavicular nerve over its acromial end, and the anterior supra clavicular nerve over its sternal end. They can be traced downwards in the superficial fascia to the level of the second rib or a little lower and are accompanied by twigs from the transverse scapular artery Twigs derived from the branches of the thoracoacromial artery are seen over the sternal end of the clavicle, over the acromion, and over the space where the deltoid and pectoral muscles meet. And lastly, look for the lateral cutaneous nerves along the side of the thorax just behind the line of the anterior fold of the axilla There is one lateral cutaneous nerve in each intercostal space except the first. The lateral cutaneous branches of the second and third intercostal nerves will be examined with the dissecton of the axilla. Find out that each of the remaining lateral cutaneous nerves divides into an anterior and a posterior branch and trace the former anteriorly and the latter posteriorly. When the cutaneous nerves and vessels have been studied the whole superficial fascia of this region should be removed.

The **Cutaneous Nerves** can be grouped into three sets :—(1) The *anterior cutaneous nerves*. These are the terminal filaments of the intercostal nerves and are found in the intercostal spaces on each side of the sternum except the first which is occasionally absent. They become cutaneous by perforating the pectoralis major close to the margin of the sternum, supply the skin over the sternum and give off branches, which proceed lateralwards as far as the anterior fold of the axilla. They are accompanied by the perforating branches of the internal mam-

mary artery. (2) The *lateral cutaneous nerves.* These are also derived from the intercostal nerves and are found about midway between the vertebral column and the sternum. They become cutaneous by perforating the external intercostal and serratus anterior muscles and divide into anterior and posterior branches. The anterior branches are directed forwards to supply the skin over the pectoral region while the posterior branches are directed backwards to supply the skin over the latissimus dorsi. The first intercostal nerve does not give off a lateral cutaneous branch. The lateral cutaneous branch of the second intercostal nerve which does not divide into an anterior and a posterior division, will be studied when the medial wall of the axillary fossa is dissected. (3) The *supraclavicular nerves* are the descending cutaneous branches of the cervical plexus. These have been described on p. 251.

Dissection. In the female subject the student should dissect the mamma to display its naked-eye structure. Raise the skin over the areola towards the summit of the nipple. Remove the fat surrounding the organ and then attempt to display the lobes, the lobules, the milk ducts and their ampullæ.

The **Mamma** (mammary gland) in the female extends from the side of the sternum to the anterior fold of the axilla horizontally, and from the third to the sixth rib vertically. It rests upon the deep fascia covering the pectoralis major and serratus anterior from which it is separated by loose connective tissue It presents at about its centre a small conical eminence called the *mammary papilla* or *nipple.* The nipple is surrounded by a dark coloured patch of skin called the *areola.* In the skin of the areola many small eminences are seen which are due to the presence of small sebaceous glands called the *areolar glands* (of Montogomery). The mamma is imbedded in the superficial fascia. It is composed of lobes and these again consist of lobules of glandular tissue which are held together by strands of fibrous tissue passing between. Most of the strands pass from the skin through the superficial fascia and between the lobules to the deep fascia and are known as *ligaments of Cooper.* The fatty tissue covers the surface of the gland and is also deposited between the lobules along the fibrous strands. The ducts, called the *tubuli lactiferi,* fifteen to twenty in number, are formed by the union of smaller ducts ; they proceed from the lobes towards the areola. Beneath the areola they become dilated and form the *ampullæ.*

At the base of the nipple they contract again and finally open upon its summit.

The mamma is supplied by the intercostal arteries, the perforating branches of the internal mammary artery, and the thoracic and external mammary branches of the axillary artery.

The *lymphatic vessels of the mamma* are important clinically. Those draining the lateral and central parts (including the nipple and areola) of the mamma open into the pectoral group of lymph glands along the lower border of the pectoralis major. Those from the medial part of the mamma drain into the sternal group of lymph glands by the side of the sternum. Occasionally some lymphatic vessels from the upper part of the mamma drain into the infraclavicular group of lymph glands.

In the male the mamma is rudimentary and the **nipple** is placed over the fourth intercostal space about four inches (10 cm.) lateral to the median line.

The **Deep Fascia** (pectoral fascia) covers the pectoralis major. It is attached above to the clavicle and medially to the front of the sternum. Below it is continuous with the deep fascia covering the abdominal muscles and, at the anterior fold of the axilla, it becomes continuous with the axillary fascia. Laterally it is continuous above with the deep fascia covering the deltoideus.

Dissection Remove the deep fascia commencing from the margin of the sternum Clean the pectoralis major and the anterior part of the deltoideus and define the anterior border of the latter muscle. The cephalic vein and the deltoid branch of the thoracoacromial artery are seen between the contiguous margins of the deltoideus and the pectoralis major. One or two deltoideo-pectoral lymph glands are to be cleaned in the deltoideo-pectoral triangle below the clavicle.

The **Pectoralis Major** (Fig 148) is a triangular muscle which extends from the sternum to the arm. It consists of a clavicular and a sternocostal portion which are separated from each other by a cellular interval. The *clavicular portion* arises from the anterior surface of the medial half of the clavicle, while the *costosternal portion* arises (1) from the cartilages of the upper six ribs, (2) from the anterior surface of the sternum, and (3) from the aponeurosis of the obliquus externus abdominis. The upper fibres of the muscle, those from the clavicle pass downwards and lateralwards ; the lower fibres pass upwards and lateralwards ; and the middle fibres pass horizontally lateralwards—ultimately

all the fibres end in a flat tendon which becomes inserted into the crest of the greater tubercle of the humerus. The details of its insertion will be examined during the dissection of the arm. The pectoralis major is supplied by the medial and lateral anterior thoracic nerves which enter its deep surface and will be seen when the muscle is reflected. *Actions.*—It adducts the arm and also rotates the humerus inwards. When the arms are fixed it raises the trunk forwards as in climbing.

The *deltoideo-pectoral triangle* or *infraclavicular fossa* is a small interspace which is bounded above by the junction of the middle and lateral thirds of the clavicle, medially by the pectoralis major, and laterally by the anterior margin of the deltoideus. In this triangle are seen the cephalic vein, the deltoid branch of the thoracoacromial artery and the *deltoideopectoral lymph glands*. These glands, one or two in number, receive lymph vessels from the lateral side of the arm and from the shoulder.

Dissection. The student should now proceed with the dissection of the axillary space. First clean the lower border of the pectoral muscles which constitutes the anterior fold of the axilla. Reflect in one piece the axillary fascia which forms the base of the axilla and stretches from the lower border of the pectoral muscles in front to the latissimus dorsi and teres major muscles behind. Then clean the lower borders of the teres major and latissimus dorsi which constitute the posterior fold of the axilla. Secure the lateral cutaneous branches of the second and third intercostal nerves at this stage and in the case of the third nerve trace its anterior and posterior branches. Remove all the fat piecemeal in the space without injuring the vessels and nerves working cautiously from the base of the axilla towards its apex which is directed upwards towards the root of the neck. Clean the distal part of the axillary artery which lies close to the lateral wall of the space. Look for the branches of the axillary artery. The lateral thoracic artery passes medialwards along the lower border of the pectoralis minor. The subscapular artery runs medialwards along the lower border of the subscapularis in the posterior wall of the space. The anterior and posterior humeral circumflex arteries pass lateralwards; the former in front of and the latter behind the surgical neck of the humerus. The axillary vein lies medial to the artery; the vein and its tributaries corresponding to the branches of the axillary artery are to be cleaned. A chain of lymph glands will be seen lying along the medial side of axillary artery.

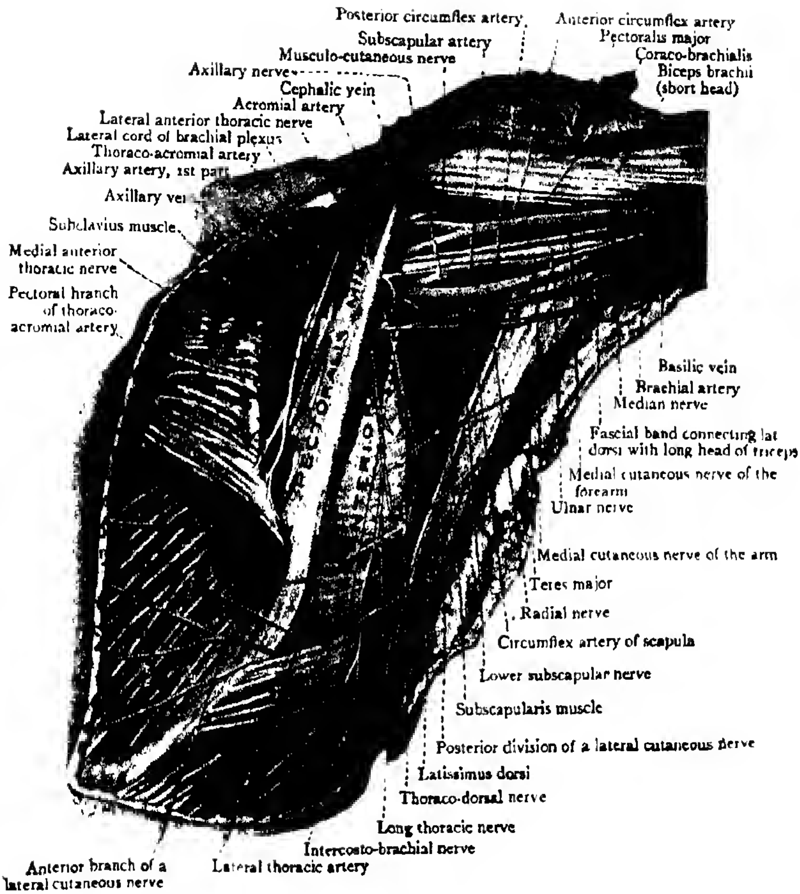


Fig. 148.—Dissection of the axilla (modified from cunningham).

To face P. 472

Another set of lymph glands will be seen along the course of the lateral thoracic artery. A third set will be seen along the course of the subscapular artery. Some lymph glands are found near the centre of the base of the axilla. One or two lymph glands of each set should be preserved. Next look for the branches of the brachial plexus. Draw the corachobrachialis laterally and find out the muscluocutaneous nerve piercing the muscle. The medial head of the median nerve will be seen to cross the axillary artery lateralwards and join the lateral head of the nerve. The ulnar nerve lies medial to and a little behind the artery. The medial antibrachial cutaneous nerve lies between the axillary artery and vein. The medial brachial cutaneous nerve lies medial to the axillary vein and is connected with the intercostobrachial nerve (lateral cutaneous branch of the second intercostal nerve) by a communicating filament. The radial nerve lies behind the axillary artery; higher up behind the artery is seen the axillary nerve before that nerve winds backwards and lateralwards round the surgical neck of the humerus. The thoracodorsal nerve crosses the subscapularis to enter the latissimus dorsi close to the medial wall. The upper and lower subscapular nerves enter the upper and lower parts respectively of the subscapularis muscle. The long thoracic nerve lies on the surface of the serratus anterior in the medial wall of the axilla. The dissector will find it difficult, at this stage of dissection, to clean the branches of the axillary artery and of the brachial plexus given off near the apex of the space.

The **Axilla** is the space between the upper part of the side of the thorax and the upper part of the arm. It may be described as a hollow four-walled pyramid with unequal walls: thus the medial wall is longer than the lateral, while the posterior wall extends further down than the anterior.

Boundaries.—The *base* is formed by the axillary fascia. The *apex* is directed towards the root of the neck being formed by a triangular interval bounded by the superior border of the scapula behind, the clavicle in front, and the outer border of the first rib medially. This triangular space is called the *cervico-axillary canal* and gives passage to the axillary vessels and nerves of the brachial plexus from the neck to the upper limb. The *anterior wall* is formed by the pectoralis major and minor muscles and the coracoclavicular fascia. The pectoralis major extends over the whole of this wall while the pectoralis minor, over its middle

third. The lower border of the anterior wall constitutes the *anterior fold* of the axilla. The *posterior wall* is formed above by the subscapularis and below by the teres major and the latissimus dorsi. The lower border of the posterior wall constitutes the *posterior fold* of the axilla. The *medial wall* is formed by the upper four ribs with the intervening intercostal muscles and the corresponding part of the serratus anterior. The *lateral wall* is formed by the upper part of the humerus together with the coracobrachialis and biceps brachii.

Contents.—The space contains the axillary artery with its branches, the axillary vein with its tributaries, the axillary lymph vessels and glands, the lower part of the brachial plexus with its infraclavicular branches, the intercostobrachial nerve, the posterior offset of the lateral cutaneous branch of the third intercostal nerve, and a quantity of fat.

Dissection. Divide the pectoralis major at its origin from the clavicle and reflect it downwards and lateralwards. Care should be taken of the lateral anterior thoracic nerve and of the pectoral branches of the thoracoacromial artery which enter the deep surface of the muscle at this situation. Trace the cephalic vein to the point where it pierces the coracoclavicular fascia. Clean the deltoid branch of the thoracoacromial artery which accompanies the cephalic vein. The acromial and clavicular branches of the same artery are also to be traced. These structures should be cleaned and preserved for subsequent study. The coracoclavicular fascia which is displayed in this dissection should now be studied.

The **Coracoclavicular Fascia** (Costocoracoid membrane) fills up the gap between the upper border of the pectoralis minor and the clavicle. Laterally it is attached to the coracoid process. Medially it is continuous over the first and second intercostal spaces with the fascia covering them and is attached to the first costal cartilage. Above it splits into two laminæ to enclose the subclavius muscle ; the laminæ are then attached to the two borders of the groove for the subclavius ; the lamina behind the subclavius blends with the fascia colli and with the sheath of the axillary vessels. Below it splits at the upper border of the pectoralis minor to enclose it ; at the lower border of the muscle the two layers reunite and become continuous with the axillary fascia. It is pierced by the cephalic vein, the thoracoacromial vessels and the lateral anterior thoracic nerve. The upper portion of the fascia, extending from the coracoid process to the

cartilage of the first rib, is thicker than the lower portion and is called the *costocoracoid ligament.*

Dissection. Clean the surface of the pectoralis minor muscle. Divide the coracoclavicular fascia below the clavicle. Raise the lower border of the subclavius by passing the handle of the scalpel and observe how the fascia splits to enclose the subclavius muscle above. Remove the remains of the coracoclavicular fascia preserving the structures which pierce it. The thoraco-acromial artery and the lateral anterior thoracic nerve are now to be traced to their origin. The cephalic vein should be traced to its termination in the axillary vein. Divide the costosternal portion of the pectoralis major two inches from the lateral margin of the sternum and reflect the medial part towards the sternum and the lateral part towards the arm. While reflecting the lateral part note the filaments of the medial anterior thoracic nerve entering its deep surface after piercing the pectoralis minor.

The **Pectoralis Minor** is a triangular muscle extending from the upper part of the thorax to the shoulder. It arises from the outer surfaces of the third, fourth and fifth ribs near their junctions with the cartilages and from the fascia covering the intercostal muscles between those ribs. Its fibres pass upwards and lateralwards and are inserted by a narrow flattened tendon into the medial border and upper surface of the coracoid process. It is supplied by the medial anterior thoracic nerve which enters its deep surface. *Actions.*—It depresses the shoulder ; when the arm is fixed, it becomes an inspiratory muscle in laborious breathing.

Dissection. Divide the pectoralis minor at about its middle and reflect the divided portions. Take care of the medial anterior thoracic nerve which enters its substance and trace it to its origin. The vessels, nerves, and lymph glands at the upper part of the axillary space close to its apex should now be thoroughly cleaned. When the whole space is fully dissected out, the contents should be studied seriatim and in detail.

The **Axillary Lymph Glands** are the deep lymph glands which are situated in the axillary region. They may be arranged into five groups :—(1) The *lateral group* which consists of four to six lymph glands and lies along the axillary vein. They drain lymph from the greater part of the superior extremity and their efferents open into the central and subclavicular groups of lymph glands. (2) The *anterior* or *pectoral group* consists of four or five lymph glands and lies along the lower border of

the pectoralis minor along the lateral thoracic artery. They drain lymph from the thoracic wall and the mamma and their efferents open into the central and subclavicular group of lymph glands. (3) The *posterior* or *subscapular group* consists of six or seven lymph glands and lies along the course of the subscapular vessels and drain lymph from the back of the neck and posterior thoracic wall. Their efferents open into the central group of lymph glands. (4) The *central* or *intermediate group* consists of three or four lymph glands embedded in fat near the centre of the base of the axilla. They receive lymph from all the former groups and their efferents open into the subclavicular lymph glands. (5) The *subclavicular group* consists of six or eight lymph glands situated near the apex of the axilla. They receive lymph from all other groups of axillary lymph glands and from the deltoideopectoral group. Their efferents form the *subclavian lymph trunk* which joins the jugular lymph trunk in the neck or may open separately into the junction of the internal jugular and subclavian veins.

The **Axillary Artery** is the direct continuation of the subclavian artery and extends from the outer border of the first rib to the lower border of the teres major muscle. Its direction varies with the position of the limb to the trunk ; it is only when the arm is at a right angle with the trunk that the direction of the artery is that of a straight line ; in any other position of the arm the direction of the artery becomes variously curved. Hence in determining the position of the artery on the surface of the body the arm is abducted to a right angle and a straight line is drawn from the midpoint of the clavicle to the medial border of the coracobrachialis where it is crossed by the lower border of the tendon of the pectoralis major. It is enclosed together with the axillary vein and the brachial plexus within a fascial sheath called the *axillary sheath*. This sheath is a prolongation downwards of the prevertebral layer of the fascia colli. In order to facilitate description it is customary to divide the axillary artery into three portions : the first portion lies above the level of the pectoralis minor ; the second portion behind the muscle ; and the third portion extends from the lower border of that muscle to the lower border of the teres major.

The *first portion* is placed deeply and lies under cover of the clavicular portion of the pectoralis major and the coracoclavicular fascia. It is crossed by the cephalic vein. The loop of communication between the lateral and medial anterior thoracic

nerves lies in front of it. Posteriorly it lies in relation with the first intercostal space and the first digitation of the serratus

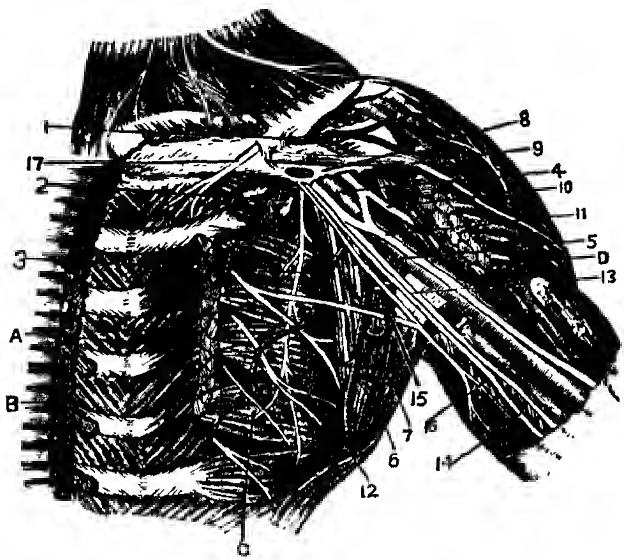


Fig. 149.—The axillary artery and its branches (drawn by G. E. L. Pearse).

A. Pectoralis minor (cut).
B. Pectoralis major (cut).
C. Serratus anterior.
D. Pectoralis major.
1. Thoracoacromial artery.
2. Highest thoracic artery.
3. Lateral thoracic artery.
4. Axillary artery.
5. Posterior humeral circumflex artery.
6. Subscapular artery.
7. Scapular circumflex artery.
8. Coracoclavicular fascia.
9. Cephalic vein.
10. Musculocutaneous nerve.
11. Median nerve.
12. Long thoracic nerve.
13. Ulnar nerve.
14. Medial antibrachial cutaneous nerve.
15. Axillary nerve.
16. Medial brachial cutaneous nerve joined by intercostobrachial nerve.
17. Lateral anterior thoracic nerve.

anterior. The medial cord of the brachial plexus, the long thoracic nerve, and the medial anterior thoracic nerve pass medialwards behind the vessel. To its lateral side are the lateral and posterior cords of the brachial plexus. To its medial side is the axillary vein, which overlaps the artery.

The *second portion* lies under cover of the two pectoral muscles. Behind it lies the posterior cord of the brachial plexus. Lateral to it is the lateral cord; and medial to it the medial cord of the brachial plexus. The medial anterior thoracic

nerve and the axillary vein also lie medially, the nerve separating the artery from the vein. Posteriorly it is not in direct contact with the subscapularis but is separated from this muscle by some fatty tissue.

The *third portion* lies under cover of the pectoralis major in its upper half but is very superficial in its lower half being covered only by the skin and superficial and deep fasciæ. It is crossed in front by the medial head of the median nerve. Posteriorly it lies in relation with the subscapularis, latissimus dorsi, and teres major in that order from above downwards. It lies over the axillary nerve above and the radial nerve below. To its lateral side are the musculocutaneous and median nerves which lie between the artery and the coracobrachialis. To its medial side are the medial antibrachial cutaneous and ulnar nerves which separate it from the axillary vein.

Branches.—The branches of the axillary artery are: from the first portion (1) the highest thoracic; from the second portion (2) the thoracoacromial and (3) lateral thoracic; from the third portion (4) the subscapular, (5) anterior humeral circumflex, and (6) posterior humeral cricumflex.

The **Highest Thoracic Artery** (Superior thoracic) is a small branch which passes medialwards, supplies the upper part of the thoracic wall and anastomoses with the intercostal and internal mammary arteries.

The **Thoracoacromial Artery** (Thoracic axis) is a short trunk which arises from the front aspect of the axillary artery. It pierces the coracoclavicular fascia and immediately divides into four branches:—(1) The *pectoral branch* (thoracic branch) which descends between the pectoral muscles, supplies them and anastomoses with the lateral thoracic and intercostal arteries. (2) The *clavicular branch* passes upwards and medialwards on the coracoclavicular fascia and supplies the subclavius muscle and the sternoclavicular joint. (3) The *acromial branch* passes lateralwards beneath the deltoideus and supplies it; it then pierces that muscle and ramifies over the acromion where it anastomoses with the branches of the transverse scapular and posterior humeral circumflex arteries. (4) The *deltoid branch* (humeral branch) often arises in common with the acromial branch; it passes downwards by the side of the cephalic vein along the interval between the clavicular portion of the pectoralis major and the deltoideus and supplies both the muscles.

The **Lateral Thoracic Artery** (long thoracic) runs downwards and medialwards along the lower border of the pectoralis minor to the thoracic wall and supplies the pectoral muscles and the serratus anterior and anastomoses with the intercostal and subscapular arteries. In the female it gives off a branch, called the *external mammary artery*, which goes to supply the mamma.

The **Subscapular Artery** is the largest branch of the axillary artery and arises at the lower border of the subscapularis. It passes downwards and medialwards along the lower border of the subscapularis to the inferior angle of the scapula where it anastomoses with the lateral thoracic and intercostal arteries. It supplies the neighbouring muscles and in the lower part of its course is accompanied by the thoracodorsal nerve. About an inch from its origin it gives off a large branch, called the *scapular circumflex artery* (dorsalis scapulæ), which curves round the axillary border of the scapula and reaches the infraspinous fossa, where it will be subsequently examined.

The **Anterior Humeral Circumflex Artery** (anterior circumflex) arises from the lateral aspect of the axillary below the preceding artery and passes lateralwards beneath the coracobrachialis and short head of the biceps brachii in front of the surgical neck of the humerus and, reaching the intertubercular sulcus, divides into two branches. One of these ascends along the intertubercular sulcus to supply the shoulder joint while the other passes lateralwards beneath the deltoideus and anastomoses with the posterior humeral circumflex artery.

The **Posterior Humeral Circumflex Artery** (posterior circumflex) arises behind the preceding artery or sometimes in common with it and is much larger than it. It passes backwards with the axillary nerve through the quadrilateral space, bounded above by the teres minor, below by the teres major, medially by the long head of the triceps brachii, and laterally by the surgical neck of the humerus. Its further course and termination will be seen later on.

The **Axillary Vein** is the continuation upwards of the basilic vein of the arm and has the same extent as the artery. It begins at the lower border of the teres major and becomes the subclavian vein at the outer margin of the first rib. At the lower border of the subscapularis it is joined by the two venæ comitantes of the brachial artery. It lies on the medial side of its companion artery. It receives tributaries corresponding

to the branches of the axillary artery and near its termination the cephalic vein opens into it.

The **Subclavius** arises by a tendon from the junction of the first rib with its cartilage. It passes upwards and lateralwards to be inserted into the groove on the under surface of the clavicle. It is supplied by a special branch from the brachial plexus given off above the clavicle; this branch is derived from the point of junction of the fifth and sixth cervical nerves. It depresses the clavicle.

The sterno-clavicular articulation should now be studied.

The **Sterno-Clavicular Articulation** is an arthrodial joint. The parts entering into the formation of the joint are the sternal end of the clavicle, the articular surface situated on the upper and lateral part of the manubrium sterni, and the first costal cartilage. The following are its ligaments: (1) The *articular capsule* which surrounds the articular surfaces of the clavicle and manubrium sterni. It is of varying thickness and strength and is attached to the margin of the articular disc interposed between the articular surfaces. (2) The *sternoclavicular ligament* strengthens the joint in front. It extends obliquely from the upper part of the anterior aspect of the sternal facet to the upper and front part of the sternal end of the clavicle. (3) The *interclavicular ligament* strengthens the articular capsule above. It extends from the upper part of the sternal end of one clavicle along the bottom of the jugular notch of the sternum to the corresponding point on the clavicle of the opposite side. (4) The *costoclavicular ligament* (Rhomboid ligament) is attached below to the upper surface of the costal cartilage of the first rib, and above to the costal tuberosity on the under surface of the medial end of the clavicle. (5) The *articular disc* is placed between the articular surfaces of the sternum and clavicle. It is flat and almost circular. It is attached above to the upper part of the posterior border of the articular surface of the clavicle and below to the cartilage of the first rib at its union with the sternum. By its circumference it is attached to the articular capsule. Each surface of the articular disc is lined by a synovial stratum.

Dissection. The student should now proceed to dissect the brachial plexus of nerves. For this purpose the middle third of the clavicle is to be removed with a saw. The subclavius muscle is then to be detached together with its nerve. It is necessary that the dissector of the superior extremity should work in conjunction with the dissector of the head and neck so

that the structures passing from the neck to the axilla may be studied in their continuity.

Brachial Plexus (Fig. 82).—The formation of the brachial plexus and its branches given off above the clavicle have been fully described on page 258 et seq. *Relations.*—When the plexus passes behind the clavicle, the subclavius and transverse scapular vessels, it rests upon the scalenus medius. In the axilla the plexus is *covered* by the two pectoral muscles and the coracoclavicular fascia and is crossed by the cephalic vein and axillary artery ; *behind* it is the first digitation of the serratus anterior and the subscapularis. The branches given off from the brachial plexus below the clavicle, called the *infraclavicular branches,* belong to the dissector of the superior extremity. These are derived from the three cords of the plexus. Three branches are given off from the lateral cord, viz., the lateral anterior thoracic nerve, the musculocutaneous nerve, and the lateral head of the median nerve. Five branches are given off from the medial cord, viz., the medial anterior thoracic nerve, the medial brachial cutaneous nerve, the medial antibrachial cutaneous nerve, the ulnar nerve, and the medial head of the medial nerve. The posterior cord also gives off five branches, viz., the upper and lower subscapular nerves, the thoracodorsal nerve, the axillary nerve, and the radial nerve.

The **Lateral Anterior Thoracic Nerve** (external anterior thoracic nerve) arises from the lateral cord of the plexus and derives its fibres from the fifth, sixth and seventh cervical nerves. It passes forwards and, crossing the axillary artery and vein, pierces the coracoclavicular fascia. It then enters the deep surface of the pectoralis major to supply it. A filament from it usually joins the medial anterior thoracic nerve forming a loop which lies in front of the axillary artery.

The **Medial Anterior Thoracic Nerve** (internal anterior thoracic nerve) arises from the medial cord and derives its fibres from the eighth cervical and first thoracic nerves. Passing behind the first portion of the axillary artery it proceeds forwards between that artery and its companion vein and is joined in front of the artery by a filament from the lateral anterior thoracic nerve. It then passes to the under surface of the pectoralis minor to be distributed to that muscle ; some filaments pierce the muscle and enter the deep surface of the pectoralis major.

Subscapular Nerves.—These arise from the posterior cord and derive their fibres from the fifth and sixth cervical nerves.

The *upper subscapular nerve,* the smaller of the two subscapular nerves, enters the upper part of the subscapularis. The *lower subscapular nerve* supplies the lower part of the subscapularis and the teres major.

The **Thoracodorsal Nerve** (middle or long subscapular nerve) arises from the posterior cord and derives its fibres from the fifth, sixth and seventh cervical nerves. It passes downwards in company with the subscapular artery along the posterior wall of the axilla to supply the latissimus dorsi.

The remaining branches of the brachial plexus will be studied during the dissection of the arm and the parts about the scapula.

The **Intercostobrachial Nerve** (intercostohumeral nerve) is the lateral cutaneous branch of the *second intercostal nerve.* Like the other lateral cutaneous branches it does not divide into an anterior and a posterior branch. The undivided nerve passes from the medial wall of the axilla along its base to the medial side of the upper part of the arm and supplies the skin over its medial and back parts. In the axilla it communicates by a filament with the medial brachial cutaneous nerve.

As a rule the *first intercostal nerve* does not give off a lateral cutaneous branch. The posterior offset of the lateral cutaneous branch of the *third intercostal nerve* is sometimes large and reaches the skin on the medial aspect of the upper part of the arm like the intercostobrachial nerve by crossing the axilla.

The *long thoracic nerve* can now be studied in its entirety and the twigs given to each digitation of the serratus anterior examined. It has been described on p. 260.

The **Serratus Anterior** (Serratus magnus) extends from the side of the thorax to the vertebral border of the scapula. It arises by fleshy digitations from the outer surfaces of the upper eight ribs—midway between angles and cartliages of the ribs. The first digitation is large and arises from two ribs, the first and the second. The remaining digitations arise from the corresponding ribs. The lower three slips interdigitate with the obliquus externus abdominis. The muscle is inserted into the ventral aspect of the whole length of the vertebral border of the scapula. The first digitation converges to be inserted into the ventral aspect of the medial angle of the scapula. The lower five digitations converge to be inserted into a triangular rough area on the ventral aspect of the inferior angle of the scapula. The second and third digitations spread out and form a thin sheet which is inserted into the intermediate portion of the ven-

tral aspect of the vertebral border of the scapula. The serratus anterior is supplied by the long thoracic nerve which lies on the surface of the muscle. *Actions.*—When the whole muscle acts the scapula is carried forwards and with it the vertebral border of the bone is also raised.

Removal of the Limb.—The superior extremity should now be removed from the trunk and taken for further dissection to the table provided for the purpose. Cut through the serratus anterior from its superior to inferior margin one inch from its attachment to the vertebral border of the scapula. Divide the inferior belly of the omohyoideus near the upper border of the scapula and the latissimus dorsi near the inferior angle of the the bone. The axillary artery and vein and the cords of the brachial plexus are to be tied separately with ligatures close to the apex of the axilla and then divided above the ligatures. The ligatures embracing the axillary vessels and nerves should be fastened to the fragment of the clavicle still left with the part or to the subjacent soft parts, so that their proper relations with one another are retained. The fixture can be removed when necessary. Next divide the transverse scapular vessels and the suprascapular nerve near the scapular notch and the dorsal scapular nerve and the descending branch of the transverse cervical artery near the medial angle of the scapula.

UPPER PART OF THE ARM AND THE SCAPULAR REGION

Dissection.—Remove the skin from the front and lateral aspects of the upper third of the arm. Trace the posterior supraclavicular nerves which cross the acromial end of the clavicle and descend over the upper part of the deltoideus. Look for the lateral brachial cutaneous nerve at the posterior border of the lower part of the deltoideus.

The **Cutaneous Nerves** are:—(1) The *posterior supraclavicular nerves.* These have been described (p. 251). They supply the skin of the front and lateral parts of the shoulder. (2) The *lateral brachial cutaneous nerve* (Fig. 150) is a branch of the posterior division of the axillary nerve. It becomes cutaneous at the posterior border of the deltoideus and passing forwards supplies the skin over the lower two-thirds of the muscle. (3) Some filaments from the anterior division of the axillary nerve pierce the deltoideus and supply the skin over it.

The **Deep Fascia** presents differences in character in the different parts of the shoulder and scapular region. Where it covers the supraspinatus muscle it is called the *fascia supraspinata* and is thicker medially than laterally. It is attached to the margins of the supraspinous fossa and from its deep surface some fibres of the supraspinatus take their origin. The *fascia infraspinata* covers the infraspinatus muscle. It is attached to the margins of the infraspinous fossa and is continuous in front with the fascia covering the deltoideus. Its deep surface gives off a strong septum which separates the infraspinatus from the two teres muscles. The *subscapular fascia* covers the subscapularis; it is thin but strong and is attached to the circumference of the subscapular fossa. The *fascia covering the deltoideus* is thin in front where it is continuous with the pectoral fascia and thick behind where it is continuous with the facsia infraspinata; below it is continuous with the brachial fascia and above it is attached to the clavicle and acromion.

Dissection. In order to dissect the deltoideus, its fibres should be made tense. For this purpose a block is to be placed between the scapula and the upper part of the arm; after removing the fat, deep fascia and cutaneous nerves, the coarse fasciculi of the muscle are to be cleaned.

The **Deltoideus** is a triangular muscle which covers the shoulder joint and gives it a rounded outline. It arises (1) from the anterior border and the adjacent upper surface of the lateral third of the clavicle, (2) from the lateral margin and surface of the acromion, and (3) from the lower lip of the posterior border of the spine of the scapula. The fibres of the muscle converge and finally end in a tendon which is inserted into the deltoid tuberosity on the lateral surface of the humerus. It is supplied by the axillary nerve. *Actions.*—It is an abductor of the arm; its anterior fibres bring the arm forwards; its posterior fibres bring the arm backwards.

Dissection. Divide the deltoideus near its origin and throw it downwards towards its insertion, without injuring the posterior humeral circumflex artery and the branches of the axillary nerve which enter its deep surface. Define the insertion of the muscle. Trace the posterior humeral circumflex artery and the branches of the axillary nerve under cover of the deltoideus and observe that they emerge through a *quadrilateral space* bounded above by the subscapularis and teres minor, below by the teres major, medially by the long head of the triceps brachii, and laterally

by the surgical neck of the humerus. Follow the artery and establish that its parent trunk is the axillary. Demonstrate that in the quadrilateral space the axillary nerve divides into an anterior and a posterior branch and that before the division it supplies a twig to the shoulder joint. Trace the anterior branch and observe that it breaks up into several filaments which enter the deep surface of the deltoideus. Some of these filaments pierce the muscle to become cutaneous. Follow the posterior branch and find the twig given off from it to the teres minor which presents an elongated gangliform swelling on it; it then supplies a few twigs to the back part of the deltoideus and eventually is continued as the lateral brachial cutaneous nerve by turning round the posterior border of the deltoideus. Next note that a large *bursa* is placed between the under surface of the deltoideus and the articular capsule of the shoulder joint; this bursa is prolonged below the acromion and does not communicate with the joint. Trace the small anterior humeral circumflex artery and find its ascending branch along the intertubercular sulcus and the transverse branch around the surgical neck of the humerus. Lastly, clean the subscapularis, and the muscles on the dorsum of the scapula.

Parts exposed on reflecting the deltoideus.—The deltoid covers the upper end of the humerus, a large bursa, the anterior and posterior humeral circumflex vessels, and the axillary nerve. Its posterior part covers the infraspinatus, teres major and minor, and long head of triceps brachii; its middle part, the supraspinatus; its anterior part, the coracoid process and the muscles attached to it, the subscapularis and the long head of the biceps brachii.

Posterior Humeral Circumflex Artery.—Its origin from the third portion of the axillary artery has been already seen. It passes backwards in company with the axillary nerve through the quadrilateral space. It winds round the surgical neck of the humerus and divides into several branches which enter the deep surface of the deltoideus; some twigs are also given to the shoulder joint. It anastomoses above with the acromial branch of the thoracoacromial artery, in front with the anterior humeral circumflex artery and below with the profunda branch of the brachial artery.

Anterior humeral circumflex artery.—The termination of this artery and its anastomosis with the posterior humeral circumflex artery should be examined now.

The **Axillary Nerve** (Circumflex nerve) (Fig. 150) arises from the posterior cord of the brachial plexus and derives its fibres from the fifth and sixth cervical nerves. At the lower border of the subscapularis it turns backwards through the quadrilateral space in company with the posterior humeral circumflex artery. In the quadrilateral space it divides into two branches, an anterior and a posterior and before the division takes place it supplies a twig to the shoulder joint. The *anterior branch* passes round the humerus under cover of the deltoideus to reach its

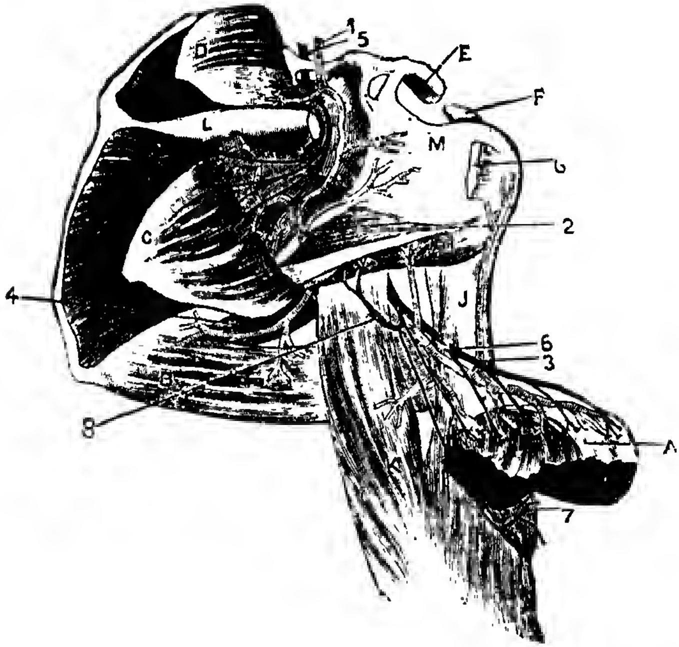


Fig. 150.—Dissection of the posterior scapular region. The triangular and quadrilateral spaces are seen from behind (Cunningham).

A. Deltoideus.
B. Teres major.
C. Infraspinatus.
D. Supraspinatus.
E. Coracoid process.
F. Tendon of supraspinatus.
G. Tendon of infraspinatus.
H. Teres minor.
J. Body of humerus.
K. Long head of triceps brachii.
L. Spine of scapula.
M. Capsule of shoulder joint.

1. Transverse scapular artery.
2. Scapular circumflex artery.
3. Posterior humeral circumflex artery.
4. Descending branch of scapular circumflex artery.
5. Suprascapular nerve.
6. Axillary nerve.
7. Lateral brachial cutaneous branch of axillary nerve.
8. Nerve to teres minor.

anterior border and breaks up into several filaments; some filaments enter the deep surface of the muscle to supply it, while others pierce the muscle and ramify in the skin covering its lower part. The *posterior branch* gives off a twig to the teres minor which presents an elongated swelling (pseudoganglion) on it. After supplying a few twigs to the back part of the deltoideus the posterior branch pierces the deep fascia and is continued as the *lateral brachial cutaneous nerve.*

The **Supraspinatus** (Fig. 150) fills up the supraspinous fossa and arises from its medial two-thirds and from the deep surface of the fascia supraspinata. The muscle passes lateralwards beneath the acromion and is inserted by its tendon into the uppermost impression on the greater tubercle of the humerus. The tendon is firmly adherent to the articular capsule of the shoulder joint. It is supplied by the suprascapular nerve. It abducts the arm.

The **Infraspinatus** (Fig. 150) arises from the medial two-thirds of the infraspinous fossa and from the deep surface of the fascia infraspinata. It is inserted into the middle impression on the greater tubercle of the humerus. Like the preceding muscle its tendon of insertion is closely blended with the articular capsule of the shoulder joint. It is supplied by the suprascapular nerve. It rotates the arm outwards.

The **Teres Minor** (Fig. 150) arises from the dorsal aspect of the upper two-thirds of the axillary border of the scapula and from two intermuscular septa one separating it from the infraspinatus and the other from the teres major muscle. It is inserted by a tendon into the lowermost impression on the tubercle of the humerus and by fleshy fibres into the surface of bone immediately below that impression to the extent of about half an inch. It is supplied by a twig from the axillary nerve. It rotates the arm outwards.

The **Teres Major** (Fig. 150) arises from the oval area on the dorsal aspect of the scapula close to its inferior angle; and from the intermuscular septa separating it from the teres minor and infraspinatus muscles. It ends in a flattened tendon which is inserted into the crest of the lesser tubercle of the humerus. It is supplied by the lower subscapular nerve. It adducts the arm and rotates it inwards.

The **Subscapularis** arises from the medial two-thirds of the subscapular fossa and from the groove on the ventral aspect of the axillary border of the scapula. The muscle passes lateral-

wards in front of the articular capsule of the shoulder joint and is inserted by a tendon into the lesser tubercle of the humerus. The tendon of insertion is blended with the articular capsule of the shoulder joint. A bursa intervenes between the tendon and the neck of the scapula and communicates with the shoulder joint through an aperture in the articular capsule. It is supplied by the upper and lower subscapular nerves. It adducts the arm and rotates it inwards.

The dissector should now examine the precise manner of insertion of each of the tendons of the following muscles, viz., the latissimus dorsi, the teres major and the pectoralis major. The quadrilateral *tendon of the latissimus dorsi* is inserted into the bottom of the intertubercular sulcus in front of the insertion of the tendon of the teres major. The tendons of those two muscles are united with each other at their lower borders but a bursa intervenes between them. The flat *tendon of the pectoralis major* is inserted into the crest of the greater tubercle of the humerus and consists of two laminæ, an anterior and a posterior. The posterior lamina is attached to the crest higher on the bone than the anterior lamina, and a fibrous expansion is given off from its upper part which is blended with the articular capsule of the shoulder joint. It should also be noted that the anterior lamina which is placed in front of the posterior receives the upper fibres (clavicular and upper sternal) of the pectoralis major, whereas the posterior lamina receives its lower fibres (from costal catilages and lower part of sternum) which are folded behind the upper fibres. The two laminæ are blended together below, i.e., the tendon is here folded upon itself.

Dissection. The supraspinatus is now to be divided about two inches from its insertion and the muscle is to be pulled backwards without injuring the vessels and nerves which supply it. The infraspinatus is to be dealt with in a similar manner. Sometimes a bursa is seen between the tendon of the infraspinatus and the articular capsule of the shoulder-joint. The distribution of the transverse scapular artery, the scapular circumflex artery, and the suprascapular nerve should now be dissected out. The subscapularis is to be detached at its origin from the scapula and reflected towards its insertion. The branches of subscapular and transverse scapular arteries, which ramify in the subscapular fossa, are exposed. A bursa will be seen lying between the muscle and the front part of the articular

capsule of the shoulder joint. This bursa communicates with the synovial stratum inside the articular capsule.

The **Transverse Scapular Artery** (Fig. 150) has been traced from its origin to the upper border of the scapula. It passes over the superior transverse ligament of the scapula to gain the supraspinous fossa beneath the supraspinatus. Here it gives off branches to the supraspinatus and a nutrient artery to the scapula. It then reaches the infraspinous fossa by passing through the great scapular notch beneath the inferior transverse ligament of the scapula. Here it supplies branches to the infraspinatus and anastomoses with the scapular circumflex artery near the axillary border and with the descending branch of the transverse cervical artery near the vertebral border of the scapula. When it crosses the superior transverse ligament it gives off a *subscapular branch* which enters the subscapular fossa beneath the subscapularis, supplies the muscle and anastomoses with the subscapular artery and with the descending branch of the transverse cervical artery.

The **Suprascapular Nerve** (Fig. 150) enters the supraspinous fossa through the scapular notch beneath the superior transverse ligament of the scapula. Here it supplies the supraspinatus and gives one articular twig to the shoulder-joint. It then passes through the great scapular notch, reaches the infraspinous fossa and supplies the infraspinatus and here it gives the second articular twig to the shoulder joint.

The **Scapular Circumflex Artery** (Fig. 150) enters the *triangular space* bounded above by the subscapularis and teres minor, below by the teres major ,and laterally by the long head of the triceps brachii. Winding round the axillary border it enters the infraspinous fossa under cover of the teres minor and anastomoses with the transverse scapular and descending branch of transverse cervical arteries. At the axillary border it gives off an *infrascapular branch* which enters the subscapular fossa beneath the subscapularis and anastomoses with the subscapular branch of the transverse scapular artery and the descending branch of the transverse cervical artery. On the dorsal aspect of the axillary border it gives off another branch which descends between the teres minor and major muscles to the inferior angle of the scapula and anastomoses with the descending branch of the transverse cervical artery.

Scapular anastomosis.—The dissector should note that very important arterial anastomoses take place on the dorsal and

ventral aspects of the scapula—between the branches of the subscapular artery, which arises from the axillary artery, and the transverse scapular and the descending branch of the transverse cervical artery, which are derived from the thyreocervical trunk of the subclavian artery.

Ligaments of the Scapula (Fig. 156).—These are: (1) The coracoacromial ligament, (2) the superior transverse ligament, and (3) the inferior transverse ligament. The *coracoacromial ligament* is a triangular band which is attached by its narrow end to the apex of the acromion and by its broad base to the lateral border of the coracoid process. This ligament together with the acromion and coracoid process forms an arch for the protection of the upper part of the shoulder joint. Beneath the acromion is a bursa which is continuous with the bursa under cover of the deltoideus. The *superior transverse ligament* (suprascapular ligament) bridges over the scapular notch. The transverse scapular artery crosses over it, while the suprascapular nerve passes beneath the ligament. It may be partly or wholly ossified. The *inferior transverse ligament* (spinoglenoid ligament) extends from the lateral border of the spine of the scapula to the adjacent margin of the glenoid cavity. The transverse scapular artery and the suprascapular nerve pass beneath it to the infraspinous fossa.

The **Acromioclavicular Articulation** is an arthrodial joint between the acromial end of the clavicle and the medial border of the acromion. The ligaments are:—(1) The *articular capsule* which surrounds the articular surfaces. It is lined by a synovial stratum which may be partially or completely subdivided into two by the articular disc inside the joint. (2) The *acromioclavicular ligament* strengthens the articular capsule superiorly and extends between the adjoining rough surfaces of the two bones. (3) The *articular disc* is sometimes found inside the joint between the articular surfaces. When present it usually extends for some distance from above downwards. Rarely it completely subdivides the joint cavity into two. Besides these there is an accessory ligament which strengthens the articulation. It is called the *coracoclavicular ligament* (Fig. 156) and consists of two bands, called the trapezoid and conoid ligaments. The *trapezoid ligament* is attached above to the oblique ridge on the under surface of the lateral third of the clavicle and below to the oblique ridge on the upper aspect of the coracoid process. The *conoid ligament* lies postero-medially to the trapezoid ligament. It

is conical in shape and is attached by its apex to the coracoid process at the junction of the vertical and horizontal parts, medial to the attachment of the trapezoid ligament. Its base is attached to the coracoid tuberosity on the under surface of the lateral third of the clavicle. It is usually separated from the trapezoid ligament by a mucous bursa. *Movements.*—This articulation permits a gliding movement of the articular surfaces and also a rotation of the scapula upon the clavicle. The two portions of the coracoclavicular ligament restrain the rotatory movements of the scapula.

THE FRONT OF THE ARM

Directions. The student should now proceed with the superficial dissection of the front of the arm concurrently with that of the front of the forearm so that the cutaneous nerves and veins can be examined in their entirety.

Surface Anatomy.—The greater tubercle of the humerus forms the prominent bony landmark of the shoulder and extends beyond the acromion. The bony landmarks near the elbow-joint should be recognised. The medial and lateral supracondylar ridges can be felt ; the lateral one is more prominent. The medial epicondyle is more conspicuous than the lateral. The latter is however seen plainly as an eminence during semiflexion of the forearm. The olecranon can always be felt at the back part of the elbow joint between the two epicondyles. The triangular subcutaneous surface at the back part of the olecranon will be felt in continuity with the dorsal border of the body of the ulna which is subcutaneous throughout its whole length. When the forearm is extended there is a slight dimple immediately below the lateral epicondyle of the humerus. This corresponds with the head of the radius. The lower fourth of the medial surface of the body of the ulna and the styloid processes of the radius and ulna should be felt. The biceps brachii forms a long prominence in front of the arm and its tendon can be easily felt at the bend of the elbow. In a fairly muscular subject three muscular elevations can be recognised on the front aspect of the elbow. The one in the middle corresponds to the tendon of the biceps brachii ; that on the lateral side corresponds to the brachioradialis and the common mass of the extensor muscles of the forearm attached to the lateral epicondyle of the humerus ; and that on the medial side corres-

ponds to the position of the pronator teres and the common mass of flexor muscles of the forearm attached to the medial epicondyle of the humerus.

Dissection. Place the limb flat on the table with the front surface uppermost. Make a longitudinal incision along the middle line of the front of the arm and forearm and a transverse incision just above the wrist joint. Raise the skin from the whole of the arm and the forearm but keep it hinged along a longitudinal attachment running down the entire length of the middle line of the dorsum of the arm and forearm—the object is to use this attached skin to cover the part when necessary. First, look for the cutaneous nerves. These are six in number in the regions now dissected. They will be found over the areas indicated in the descriptions of these nerves given below. Four superficial veins will be found in the present dissection. They are to be traced in accordance with the description given on p. 494. Lastly, try to find the supratrochlear lymph glands which lie above the medial epicondyle of the humerus on the medial side of the basilic vein.

The **Cutaneous Nerves** are:—(1) The intercostobrachial nerve, (2) the posterior brachial cutaneous branch of the radial nerve, (3) the medial brachial cutaneous nerve, (4) the medial antibrachial cutaneous nerve, (5) the dorsal antibrachial cutaneous branch of the radial nerve, and (6) the lateral antibrachial cutaneous nerve.

The *intercostobrachial nerve* is the lateral cutaneous branch of the second intercostal nerve. It has been traced from its origin to the medial side of the arm (p. 482). It supplies the skin of the medial and posterior aspects of the upper half of the arm.

The *posterior brachial cutaneous branch of the radial nerve* (internal cutaneous branch of the musculospiral nerve) arises in the axilla, passes to the back part of the arm and supplies the skin on its dorsal aspect. It can be traced as far as the olecranon. It communicates with the intercostobrachial nerve.

The *medial brachial cutaneous nerve* (Nerve of Wrisberg, lesser internal cutaneous nerve) pierces the deep fascia on the medial aspect of the arm at about its middle and supplies the skin on the medial and back part of the lower third of the arm.

The *medial antibrachial cutaneous nerve* (internal cutaneous nerve) also pierces the deep fascia usually with the basilic vein on the medial aspect of the arm at about its middle and divides

into two branches, volar and ulnar. The *volar branch* passes beneath the median cubital vein and then descends along the volar aspect of the medial side of the forearm supplying the skin as low down as the wrist. The *ulnar branch* passes in front of the medial epicondyle, then curves round to the dorsum of the forearm and proceeds downwards on its medial side as far as the wrist.

The *dorsal antibrachial cutaneous nerve* (external cutaneous branch of the musculospiral nerve) arises from the radial nerve. Piercing the lateral head of the triceps brachii it divides into two branches, an upper and a lower. Both become cutaneous by piercing the deep fascia at the lateral side of the arm at about its middle. The *upper branch* is the smaller and runs

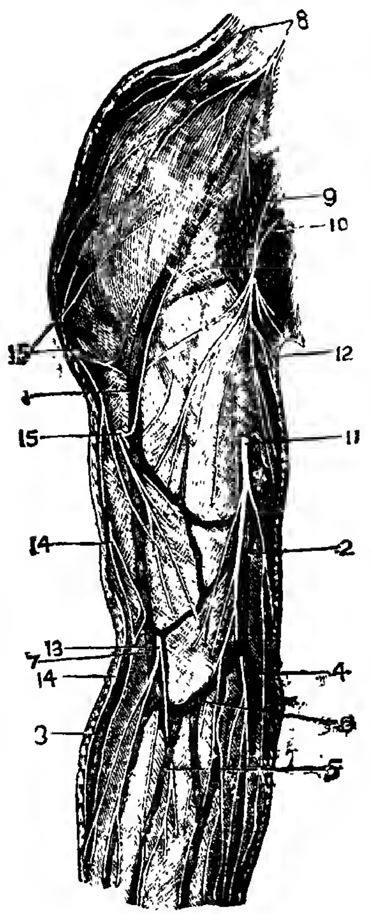


Fig. 151.—Cutaneous dissection of the front of the arm (from Hirschfeld and Leveille).

1. Cephalic vein.
2. Basilic vein.
3. Cephalic vein.
4. Basilic vein.
5. Median antibrachial vein dividing into 6, 7, median basilic and median cephalic veins.
8. Posterior supraclavicular branches.
9. Medial brachial cutaneous nerve.
10. Intercostobrachial nerve.
11. Medial antibrachial cutaneous nerve.
12. Posterior brachial cutaneous branch of radial nerve.
13. Musculocutaneous nerve.
14. Dorsal antibrachial cutaneous branch of the radial nerve.
15. Axillary nerve.

close to the cephalic vein ; it supplies the skin of the lower third of the arm on its lateral aspect. The *lower branch* descends along the lateral side of the arm and the dorsal aspect of the forearm to the wrist supplying the skin and communicating with the dorsal branches of the lateral antibrachial cutaneous nerve.

The *lateral antibrachial cutaneous nerve* is the cutaneous part of the musculocutaneous nerve. It pierces the deep fascia in front of the elbow, passes downwards behind the cephalic vein along the radial side of the front of the forearm to the wrist. Its terminal twig will be traced to the ball of the thumb during the dissection of the palm. Near the wrist it communicates with the superficial branch of the radial nerve. In its course along the forearm it gives off branches which pass dorsally round the radial border of the forearm and communicates with the dorsal antibrachial cutaneous nerve.

Superficial Veins.—The superficial veins of the forearm are four in number ; the cephalic, the basilic, the median cubital and the median antibrachial vein.

Cephalic vein.—Its origin from the lateral end of the dorsal venous network of the hand will be seen later on. It ascends along the dorsal aspect of the radial side of the forearm and gradually reaches its front aspect by winding round its radial margin. It then ascends along the front aspect of the radial side of the forearm receiving tributaries in its course and at the bend of the elbow it communicates with the basilic vein by a venous channel called the *median cubital vein.* On account of this communication, a portion of the blood contained in the cephalic vein is conveyed to the basilic vein into which the median cubital vein opens. Above the level of the median cubital vein the cephalic vein passes upwards close to the lateral border of the biceps brachii and at the upper part of the arm ascends between the deltoideus and the pectoralis major. It then pierces the coracoclavicular fascia and terminates in the axillary vein. One of the tributaries is larger than the others and is called the *accessory cephalic vein ;* it runs along the dorsal aspect of the radial border of the forearm and joins the cephalic vein a little below the bend of the elbow.

Basilic vein.—Its origin at the medial end of the dorsal venous network of the hand will be seen later on. From its origin it passes upwards at first along the dorsal aspect of the ulnar side of the forearm. Below the elbow it passes to the

front aspect of the ulnar side of the forearm. At the bend of the elbow it is joined by the medial cubital vein. It then ascends along the medial border of the biceps brachii and pierces the deep fascia at about the middle of the arm. Finally it runs along the medial side of the brachial artery and, reaching lower border of the teres major, becomes the axillary vein.

The *median cubital vein* (median basilic vein) arises from the cephalic vein at the bend of the elbow and passes upwards and medialwards to join the basilic vein. The vein lies on a thickened band of fascia derived from the tendon of insertion of the biceps brachii, called the lacertus fibrosus, which separates it from the brachial artery.

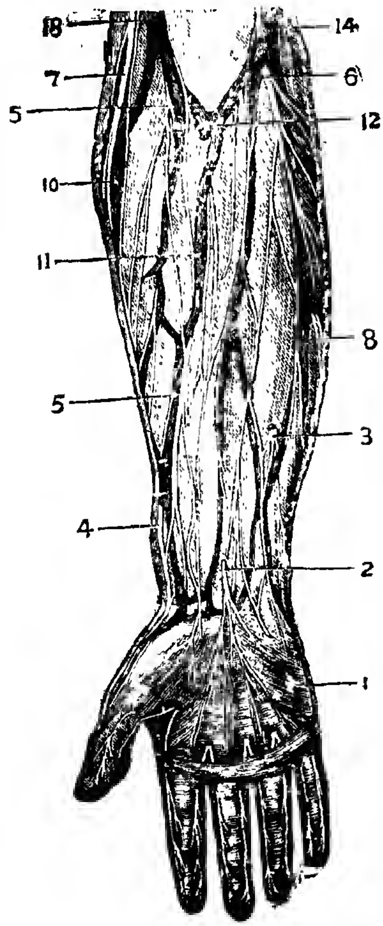


Fig. 152.—Cutaneous dissection of the front of the forearm and hand (from Hirschfeld and Leveille).

1. Palmaris brevis.
2. Palmar cutaneous branch of median nerve.
3. Palmar cutaneous branch of ulnar nerve.
4. Lateral branch of superficial branch of radial nerve.
5. Musculocutaneous nerve.
6. Medial antibrachial cutaneous nerve.
7. Dorsal antibrachial cutaneous branch of radial nerve.
8. Basilic vein.
10. Cephalic vein.
11. Median antibrachial vein.
12. A communicating vein joining the bifurcation of the median antibrachial vein.
13. Cephalic vein.
14. Basilic vein.

The *median antibrachial vein* begins in a venous plexus on the volar aspect of the hand and ascends along the middle line of the front of the forearm to join the median cubital vein or the basilic vein at the bend of the elbow. Sometimes the median cubital vein is absent. Under such circumstances the median antibrachial vein usually bifurcates at the bend of the elbow into two branches, median basilic and median cephalic. The *median basilic vein* passes upwards and medialwards to join the basilic vein; and the *median cephalic vein* passes upwards and lateralwards to join the cephalic vein. Figure 151 shows this arrangement. Before its bifurcation it communicates with the venæ comitantes of the brachial artery.

Superficial lymph glands.—One or two small lymph glands, called the *supratrochlear lymph glands*, will be seen just above the medial epicondyle of the humerus on the medial side of the basilic vein. They receive superficial lymphatic vessels from the ulnar side of the forearm and hand including the middle, ring and little fingers. Their efferents accompany the basilic vein and drain into the lateral group of axillary lymph glands.

Brachial Fascia.—The deep fascia of the arm or the brachial fascia forms a covering for the muscles of the arm. Above it is continuous with the fascia covering the deltoideus and the pectoralis major and receives expansions from their tendons. Above and medially it is continuous with the axillary fascia. Below it is continuous with the deep fascia of the forearm and is attached to the epicondyles of the humerus and the olecranon. In front of the elbow-joint it is strengthend medially by the lacertus fibrosus. Partitions or septa are given off from the deep surface of the brachial fascia. These are known as the medial and lateral intermuscular septa. To see their connections divide the deep fascia vertically along the middle line of the forearm and reflect them on either side. The *medial intermuscular septum* is attached to the medial supracondylar ridge and extends above as far as the insertion of the coracobrachialis. The *lateral intermuscular septum*, weaker than the preceding, is attached to the lateral supracondylar ridge and extends above as far as the insertion of the deltoideus. These septa and the bone divide the arm into two compartments, an anterior and a posterior (Fig. 153). As the dissection proceeds the student will notice the structures contained in each of these compartments.

The muscles is front of the arm are now to be studied. These are (1) the biceps brachii which lies in the middle; (2) the

coracobrachialis which lies medially and reaches down to the middle of the arm; and (3) the brachialis which lies beneath the biceps brachii.

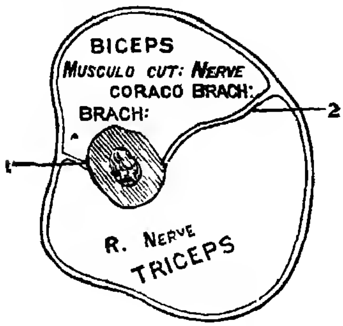


Fig. 153.—Diagram of the transverse section of the upper arm showing the intermuscular spta and the anterior and posterior compartments (after Turner). 1. Lateral intermuscular septum. 2. Medial intermuscular septum.

The **Biceps Brachii** has two heads of origin, *viz.*, a long head and a short head. The origin of the *long head* from the supraglenoid tuberosity of the scapula and from the adjacent glenoidal labrum lies within the capsule of the shoulder joint; it will be seen during the dissection of the shoulder joint. The tendon of the long head issues through an aperture in the capsule of shoulder joint. It then descends along the intertubercular sulcus being retained at this situation by a prolongation from the tendon of the pectoralis major and by the transverse humeral ligament. It ends in a fleshy belly which unites with that of the short head. The *short head* arises from the tip of the coracoid process of the scapula by a tendon in common with the origin of the coracobrachialis. It ends in a fleshy belly which unites with that of the long head at about the middle of the arm to form one muscle. The two bellies are at first closely applied to each other and can be separated but are firmly united in lower third of the arm. Towards the bend of the elbow they end in a strong tendon which is inserted into the posterior part of the tuberosity of the radius. If this tendon of insertion is examined carefully, it will be seen that (1) the posterior part of the tendon receives the fibres of the long head and the anterior part those of the short head; (2) it is twisted in such a way that its anterior surface becomes lateral before it is inserted into the radial tuberosity; (3) a bursa is interposed between the tendon and the anterior part of the tuberosity. Opposite the bend of the elbow the tendon gives off from its medial margin a strong broad aponeurosis, called the *lacertus fibrosus* (bicipital fascia), which passes downwards and medialwards and blends

with the deep fascia covering the pronator teres and the origins of the flexor muscles. The median cubital vein and the volar branch of the medial antibrachial cutaneous nerve lie over, and the brachial artery lies under cover of the lacertus fibrosus. *Relations.*—At the upper part the biceps brachii is covered by the pectoralis major and deltoideus; at its lower end the tendon dips into the cubital fossa; between these two parts it is covered by the fasciæ and skin. Its medial border lies in relation with the coracobrachialis in the upper half of the humerus and below that with the brachial vessels and median nerve; its lateral border, with the deltoideus and brachioradialis. It rests upon the shoulder joint, upper part of the humerus, brachialis, musculocutaneous nerve and supinator. The biceps brachii is supplied by the musculocutaneous nerve. *Actions.*—It is a flexor of the elbow and shoulder joints and a powerful supinator of the forearm. The lacertus fibrosus is a tensor of the antibrachial fascia.

The **Coracobrachialis** arises from the tip of the coracoid process in common with the short head of the biceps brachii. It proceeds along the medial margin of the biceps brachii and is inserted into the medial surface and border of the body of the humerus at about its middle. It is supplied by the musculocutaneous nerve which usually gives off a branch to it before piercing the muscle. It moves forwards the arm and also adducts the arm to the thorax.

The **Brachialis** (Brachialis anticus) covers the lower half of the front of the humerus and the front of the elbow joint. It arises (1) from the lower half of the anteromedial and anterolateral surfaces of the body of the humerus, (2) from the medial intermuscular septum, and (3) from the upper part of the lateral intermuscular septum. The origin from the body of the humerus is prolonged in two slips which embrace the insertion of the deltoideus. The muscle terminates in front of the elbow joint in a thick tendon which is inserted into the tuberosity of the ulna and into an impression on the anteroinferior surface of the coronoid process. It is for the most part covered by the biceps brachii. On it lie the brachial artery, the musculocutaneous and median nerves. It is intimately connected with the articular capsule of the elbow joint by its deep surface. It is supplied chiefly by the musculocutaneous nerve and receives also one or two filaments from the radial nerve. It flexes the elbow joint.

Dissection. The dissector should now examine the course

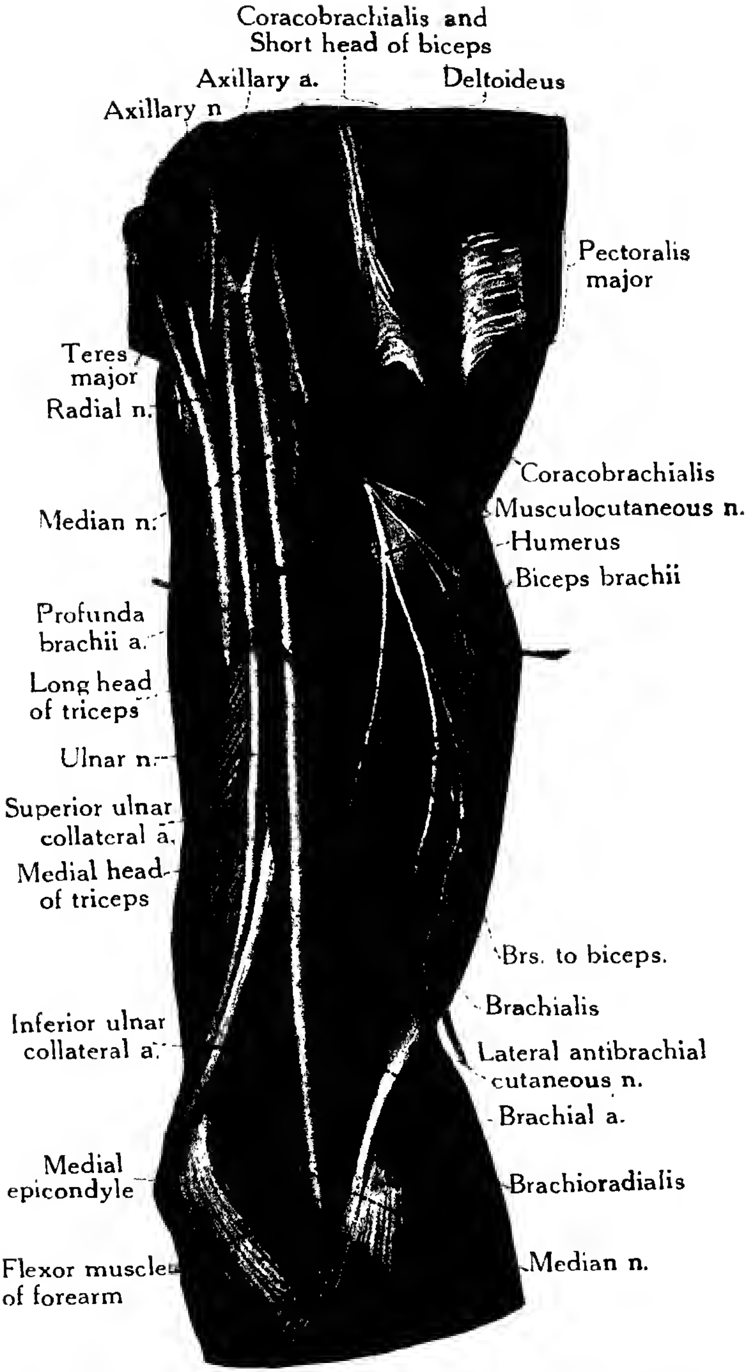


Fig. 154.—Dissection of the front of the arm and the cubital fossa (Sobotta).

and relations of the brachial artery with its branches, and the nerves of the arm. If the ligatures embracing the axillary vessels and nerves have been taken off from the fragment of the clavicle they should again be tied to that fragment. The object of this is to preserve undisturbed the relations of the brachial artery and its branches and the nerves of the arm when they are dissected out. First clean the brachial artery, and trace it to its bifurcation at the bend of the elbow. Note its relations and then trace its branches. While cleaning the brachial artery note the venæ comitantes of the artery which communicate with each other at short intervals over the artery and ultimately end in the axillary vein. Next trace the median nerve and observe that it does not usually give off any branch in the arm. The ulnar nerve will be seen to be accompanied by the superior ulnar collateral artery from the level of the insertion of the coracobrachialis. The radial nerve will be seen to take a backward course accompanied by the arteria profunda brachii. *The musculocutaneous nerve will be seen to run between the* biceps brachii and brachialis after it has pierced the coracobrachialis. The proximal parts of the medial brachial and antibrachial cutaneous nerves under the deep fascia are to be traced to the medial cord of the brachial plexus. The inferior ulnar collateral branch of the brachial artery will be seen taking its origin about two inches above the elbow joint and passing medially to the medial intermuscular septum, where it divides into an anterior and a posterior branch. Trace the anterior branch in front of the septum. The muscular branches of the brachial artery which arise from its lateral side should be preserved.

The **Brachial Artery** is the continuation of the axillary artery and extends from the lower border of the teres major muscle to about half an inch below the bend of the elbow opposite the neck of the radius where it divides into the radial and ulnar arteries. At the upper part of the arm it lies to the medial side of the humerus, but lower down it gradually inclines lateralwards and lies on the front aspect of the bone. At the bend of the elbow it is placed midway between the two epicondyles. It is accompanied by two *venæ comitantes* which communicate with each other at short intervals by cross branches.

Relations.—The artery is superficial throughout its whole extent being covered by the skin and the superficial and deep

fasciæ. The lacertus fibrosus lies between it and the median cubital or median basilic vein at the bend of the elbow. It is crossed by the median nerve at about its middle from the lateral to the medial side. Laterally it is overlapped by the coraco-brachialis above and the biceps brachii below ; the median nerve lies lateral to it in the upper half of the arm. On its medial side are the medial antibrachial cutaneous and ulnar nerves on the upper half of the arm and the median nerve on the lower half. The basilic vein lies medial to the artery throughout the whole length of the arm. Posteriorly it is in relation from above downwards with the long head of the triceps brachii (the radial nerve and the arteria profunda brachii intervening), the medial head of the same muscle, the coracobrachialis, and the brachialis.

Branches.—(1) The *arteria profunda brachii* (superior profunda artery) arises from the medial and back part of the parent trunk a little below the tendon of the teres major and passes backwards between the lateral and medial heads of the triceps brachii accompanied by the radial nerve. Its course along the radial sulcus of the humerus will be traced during the dissection of the back of the arm. Its *terminal part* (anterior branch of superior profunda artery) appears laterally in front of the arm by piercing the lateral intermuscular septum with the radial nerve. It then descends along the interval between the brachialis medially, and the brachioradialis and extensor digitorum longus laterally, to the front of the lateral epicondyle where it anastomoses with the radial recurrent branch of the radial artery.

(2) The *superior ulnar collateral artery* (inferior profunda artery) arises near the middle of the arm, passes downwards and medialwards and pierces the medial intermuscular septum with the ulnar nerve. It then descends behind the septum accompanied by the ulnar nerve to the interval between the olecranon and the medial epicondyle of the humerus. Here it anastomoses with the dorsal ulnar recurrent and inferior ulnar collateral arteries.

(3) The *inferior ulnar collateral artery* (anastomotica magna) arises about two inches (5 cm.) above the elbow joint, passes medialwards upon the brachialis and divides into two branches, an anterior and a posterior. The *anterior branch* descends in front of the medial epicondyle of the humerus to anastomose with the volar ulnar recurrent artery. The *posterior branch* proceeds to the posterior aspect of the arm by piercing the medial

intermuscular septum and will be traced during the dissection of the back of the arm.

(4) The *nutrient artery* of the humerus usually arises about the middle of the arm. It enters the nutrient foramen of the bone near the insertion of the coracobrachialis.

(5) The *muscular branches*, about four or five in number, are derived from the lateral side of the brachial artery and supply the muscles on the front of the arm.

Musculocutaneous Nerve (Fig. 148).—Its origin from the lateral cord of the brachial plexus has been examined. It passes obliquely downwards and lateralwards, supplies a branch to the coracobrachialis and then pierces the muscle. Continuing its course downwards and lateralwards it passes between the biceps brachii in front and the brachialis behind, supplies filaments to both the muscles and reaches the lateral border of the tendon of the biceps brachii at the bend of the elbow. There it perforates the deep fascia and is continued down into the forearm as the lateral antibrachial cutaneous nerve (p. 494).

Median Nerve.—Its origin in the axilla by two heads, viz., a lateral head derived from the lateral cord and a medial head derived from the medial cord of the brachial plexus, has been examined (p. 473). The two heads unite either in front of or on the lateral side of the third portion of the axillary artery. The nerve then descends on the lateral side of the brachial artery, crosses that vessel at about the middle of the arm and descends along its medial side to the bend of the elbow lying in front of the brachialis and covered by the lacertus fibrosus. It usually gives off no branch in the arm.

Ulnar Nerve.—Its origin from the medial cord of the brachial plexus has been examined (p. 481). It runs downwards along the medial side of the axillary and brachial arteries to the middle of the arm. Here, accompanied by the superior ulnar collateral artery, it passes backwards and pierces the medial intermuscular septum. It then descends along the medial head of the triceps to the interval between the medial epicondyle of the humerus and the olecranon. It gives off no branch in the arm.

Medial Antibrachial Cutaneous Nerve (Internal cutaneous nerve).—Its origin from the medial cord of the brachial plexus has been noted (p. 481). It descends along the medial side of the axillary and brachial arteries and pierces the deep fascia at about the middle of the arm. The rest of its distribution has been seen (p. 492). Before it perforates the deep fascia it gives off

a cutaneous branch which supplies the skin over the biceps brachii as low down as the elbow.

The **Medial Brachial Cutaneous Nerve** (Lesser internal cutaneous nerve) is also derived from the medial cord of the brachial plexus. Its course along the medial side of the axillary vein and its communicating twig to the intercostobrachial nerve have been noted (p. 473). It continues downwards along the medial side of the brachial artery and perforates the deep fascia at about the middle of the arm. The rest of its course has been already seen (p. 492).

The student should note that an examination of the middle of the arm reveals the following important facts: (1) the insertions of the deltoideus and coracobrachialis; (2) emergence of the medial brachial and antibrachial cutaneous nerves through the deep fascia; (3) the entrance of the basilic vein through the deep fascia; (4) the position of the nutrient foramen of the humerus; (5) the origin of the superior ulnar collateral artery and the perforation of the medial intermuscular septum by this artery and the ulnar nerve; and (6) the median nerve crossing the brachial artery.

Dissection of the Cubital Fossa.—The incisions required for the special dissection of the cubital fossa are: (1) a transverse incision across the front of the arm two inches above the bend of the elbow; (2) a transverse incision across the front of the forearm at the junction of its upper and middle thirds; (3) a median vertical incision connecting the two transverse incisions. The skin, superficial and deep fasciæ are to be reflected on either side keeping intact the cutaneous nerves and superficial veins. Divide the lacertus fibrosus about half an inch medial to the tendon of the biceps brachii and reflect it medialwards. The median cubital vein, the basilic and cephalic veins, and the lateral and medial antibrachial cutaneous nerves are to be drawn aside to suit the convenience of the next stage of dissection. The muscles forming the medial and lateral boundaries of the fossa are then to be cleaned and drawn wide apart and secured with hooks to make room for further dissection. Now clean the brachial artery and find its division into radial and ulnar arteries opposite the neck of the radius; note also the venæ comitantes of the brachial artery which may be removed if required. Next, find the radial recurrent artery issuing from the radial artery. Its anastomosis with the terminal part of the profunda will be seen in the interval between the brachialis and the brachioradialis in well-

injected subjects. Find the volar and dorsal ulnar recurrent arteries springing from the ulnar artery. Trace the former upwards between the brachialis and pronator teres to the front of the medial epicondyle and the latter under cover of the flexor carpi ulnaris to the back of the same epicondyle. In well-injected subjects their anastomoses with the superior and inferior ulnar collateral arteries will be seen. Trace the median nerve and find the branches given off in the fossa to the muscles arising from the medial epicondyle. The termination of the radial nerve will be seen in the interval between the brachioradialis and the brachialis. Trace it to its division into superficial and deep branches on the supinator. Observe the mode of insertion of the tendon of the biceps brachii. Lastly clean the floor of the fossa and note that it is formed by the brachialis and the supinator.

The **Cubital Fossa** (Anticubital space) is a triangular space at the bend of the elbow. The *base* of the triangle is directed upwards towards the humerus and is represented by a line joining the two epicondyles of the humerus; the *medial boundary* is formed by the pronator teres and the *lateral boundary* by the brachioradialis. The *apex* of this space corresponds to the meeting of the two muscles below. The structures which form the coverings or *roof* of the space have been already seen. These are :—the skin, the superficial fascia, the deep fascia with the lacertus fibrosus the median cubital vein or the median basilic and median cephalic veins, the lateral and medial antibrachial cutaneous nerves. The *floor* is formed by two muscles, the brachialis and the supinator. The *contents* proper of the fossa are :—(1) the termination of the brachial artery with its venæ comitantes which occupies the middle of the fossa and the bifurcation of the brachial into the radial and ulnar arteries; (2) the median nerve which lies on the medial side of the brachial artery; and (3) the tendon of the biceps brachii which lies lateral to the vessel. Other structures will be seen overlapped by the medial and lateral boundaries of the fossa. Thus by pulling the brachioradialis a little lateralwards, and in the interval between it and the brachialis, the radial nerve, and, in well injected subjects, the anastomosis between the radial recurrent artery and the terminal branch of the arteria profunda brachii will be seen. By pulling the pronator teres a little medialwards the anastomosis between the anterior branch of the inferior ulnar collateral artery and the volar ulnar recurrent artery will be seen.

THE BACK OF THE ARM

Dissection. Put the limb in a semiflexed position by placing a block beneath the elbow. Draw the scapula in a line with the humerus and fasten it in that position with hooks. Reflect the deep fascia on either side after making a vertical median incision. During reflection do not injure the dorsal antibrachial cutaneous nerve. Trace the ulnar nerve, the superior ulnar collateral artery and the posterior branch of the inferior ulnar collateral artery behind the medial intermuscular septum. Then clean the three heads of the triceps brachii.

The **Triceps Brachii** (Fig. 150) occupies the whole of the back of the arm and arises by three heads, a long head, a lateral head, and a medial head. The *long head* arises from the infraglenoid tuberosity of the scapula by a flattened tendon. The *lateral head* arises (1) from the posterior surface of the body of the humerus extending from the insertion of the teres minor to the upper margin of the radial sulcus; (2) from the lateral intermuscular septum; (3) from a fibrous arch which bridges over the radial sulcus and protects the structures contained in the sulcus. The *medial head* arises from the posterior surface of the body of the humerus below the radial sulcus and from both the intermuscular septa. The three heads join the common tendon of insertion of the triceps which begins at about the middle of the arm and is inserted into the back part of the superior surface of the olecranon. This tendon consists of two aponeurotic laminæ, one of which is placed superficially over the muscle and the other deeply in the substance of the muscle. Both laminæ receive the muscular fibres, then unite together above the elbow and become inserted into the olecranon. An expansion of the tendon is prolonged laterally over the anconæus and is blended with the deep fascia of the forearm. Some fibres of the medial head have direct insertion into the olecranon in front of the tendinous insertion. The muscle is supplied by branches from the radial nerve. It is the chief extensor muscle of the forearm. The long head is an adductor of the arm.

A few of the deep fibres from the lower part of the triceps brachii are inserted into the posterior part of the articular capsule of the elbow joint constituting the muscle known as *subanconæus.*

Dissection. The radial nerve and the arteria profunda brachii should now be exposed into the radial sulcus of the humerus and traced; for this purpose the lateral head of

Fig 155.—Dissection of the back of the arm (Sobotta).

the triceps brachii bordering upon the radial sulcus should be divided.

The **Radial Nerve** (Musculospiral nerve) is the largest branch of the brachial plexus and may be regarded as the direct continuation downwards of the posterior cord. At first it descends behind the axillary artery and the upper part of the brachial artery. It then proceeds backwards and passes with the arteria profunda brachii along the radial sulcus of the humerus between the lateral and medial heads of the triceps brachii. Reaching the lateral side of the limb it pierces the lateral intermuscular septum to gain the front aspect of the arm. It then passes downwards in the interval between the brachialis medially and the brachioradialis and extensor carpi radialis longus laterally to the front of the lateral epicondyle of the humerus where it divides into two terminal branches, the superficial and deep (Figs. 154, 157).

Branches.—The radial nerve gives off muscular, cutaneous and terminal branches. At the back aspect of the arm the *muscular branches* supply the three heads of the triceps brachii and the anconæus. The nerve to the medial head of the triceps is a long, slender branch which, on account of its lying close to the ulnar nerve, is called the *ulnar collateral nerve.* The nerve to the anconæus is a slender branch which descends through the substance of the medial head of the triceps and ends in the anconæus. It is accompanied by the middle collateral branch of the arteria profunda brachii. At the front aspect of the arm the muscular branches supply the lateral part of the brachialis and the brachioradialis and extensor carpi radialis longus. The *cutaneous branches,* viz., the posterior brachial cutaneous and dorsal antibrachial cutaneous nerves have been already studied (p. 492). The terminal branches will be examined later on.

The *arteria profunda brachii* has been traced up to the radial sulcus of the humerus. Accompanied by the radial nerve, it passes along the radial sulcus and reaches the lateral side of the arm. It now pierces the lateral intermuscular septum with the radial nerve and appears in front of the arm; its course along the front aspect of the arm has been noted (p. 500). *Branches.*—(1) The *radial collateral branch* (posterior branch of the superior profunda) issues before the profunda brachii artery and pierces the lateral intermuscular septum; it runs downwards along the back aspect of the lateral intermuscular septum to the back part of the lateral epicondyle of the humerus and anastomoses with the

interosseous recurrent artery. Across the back part of the humerus it forms an anastomotic arch with the inferior ulnar collateral artery. To expose this anastomotic arch divide the triceps brachii above the olecranon. On raising the muscle the arterial arch will be seen lying between the muscle and the posterior aspect of the humerus above the olecranon fossa. (2) *Muscular branches* are given off to the deltoideus, triceps and other muscles between which it passes. (3) A *nutrient artery* enters the humerus usually behind the deltoid tuberosity. (4) The *middle collateral branch* descends through the medial head of the triceps in company with the nerve to the anconæus and joins the anastomotic arch above the olecranon fossa. (5) A *branch* ascends between the long and lateral heads of the triceps brachii and anastomoses with the posterior humeral circumflex artery.

The *posterior branch of the inferior ulnar collateral artery* has been seen to pierce the medial intermuscular septum and reach the back aspect of the arm. Here it gives off a branch which passes downwards to anastomose with the dorsal ulnar recurrent artery behind the medial epicondyle of the humerus It then turns laterally between the posterior surface of the humerus and the medial head of the triceps brachii and completes the anastomotic arch with the radial collateral branch of the arteria profunda brachii.

As the triceps brachii has been divided above the olecranon the insertion of the subanconæus should be examined. A small bursa will be seen between the tendon of the triceps brachii and the anterior part of the olecranon. The medial and lateral intermuscular septa are to be fully examined. The former is perforated by the ulnar nerve, the superior ulnar collateral artery and the posterior branch of the inferior ulnar collateral artery; the latter, by the radial nerve and arteria profunda brachii.

HUMERAL ARTICULATION OR SHOULDER JOINT

The shoulder joint is an enarthrodial or ball-and-socket joint. The bones entering into the formation of this joint are the glenoid cavity of the scapula and the head of the humerus. The ligaments of this articulation should now be studied. Clean the articular capsule by carefully separating the remains of the muscles surrounding it

The **Articular Capsule** (Fig. 156) encircles the joint on all sides, being attached above to the circumference of the glenoid cavity beyond the glenoidal labrum and to the labrum itself. Below it is attached to the anatomical neck of the humerus The capsule is very loose: when all the muscles surrounding it are divided the articular surfaces can be drawn apart for about an inch (2.5 cm). Atmospheric pressure and the muscles surrounding the joint keep the articular surfaces in apposition. It usually presents three apertures: one is placed near the root of the coracoid process through which the synovial stratum of the joint protrudes in the form of a bursa beneath the tendon of the subscapularis; the second is situated between the two tubercles of the humerus through which the long tendon of the biceps passes out of the capsule carrying with it a tubular prolongation of the synovial stratum into the intertubercular sulcus; the third, which is not constant, is placed on the posterior aspect of the capsule and permits the protrusion of the synovial stratum of the joint in the form of a bursa under cover of the tendon of the infraspinatus The muscles which lie in immediate relation with the articular capsule and strengthen the joint should be noted Thus the supraspinatus lies above; the infraspinatus and teres minor are placed behind; the long head of the triceps brachii lies below; and the subscapularis, in front.

Open the posterior part of the capsule by a longitudinal

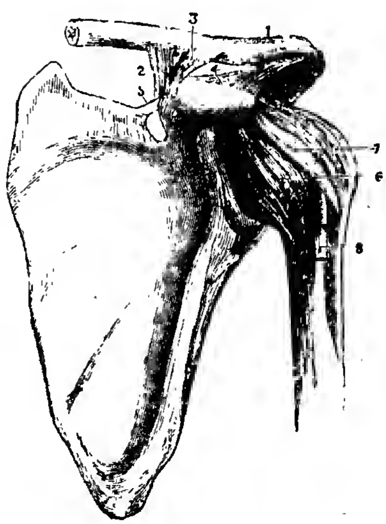


Fig. 156.—Ligaments of the scapula and shoulder joint.

1. Acromioclavicular ligament.
2. Trapezoid ligament.
3. Conoid ligament.
4. Coracoacromial ligament.
5. Superior transverse ligament of scapula.
6. Articular capsule.
7. Coracohumeral ligament.
8. Long tendon of biceps brachii.

incision and through the opening dislocate the head of the humerus ; then remove the head with a saw. Three accessory bands strengthening the articular capsule are seen.

Glenohumeral ligaments.—These are three accessory bands which extend from the margin of the glenoid cavity to the humerus. The superior band (glenohumeral ligament) is attached above to the apex of the glenoid cavity and, running parallel and medial to the long tendon of the biceps brachii, is fixed to a small depression above the lesser tubercle of the humerus. The middle band (Flood's ligament) extends from the medial margin of the glenoid cavity to the lesser tubercle of the humerus below the attachment of the superior band. The inferior band (Schlemm's ligament) passes from the lower margin of the glenoid cavity to the lower part of the anatomical neck of the humerus.

The **Coracohumeral Ligament** strengthens the capsule on its superior aspect. It is a strong broad band which is attached above to the lateral border of the root of the caracoid process. It passes downwards and lateralwards and is attachted to the anatomical neck of the humerus above the greater tubercle. Posteriorly the ligament is blended with the articular capsule, but its anterior border is free and only overlaps the articular capsule.

The **Transverse Humeral Ligament** stretches across the upper part of the intertubercular sulcus between the greater and lesser tubercles and converts the sulcus into an osseofibrous canal.

The **Glenoidal Labrum** (glenoid ligament) consists of a fibro-cartilaginous band attached to the margin of the glenoid cavity. At the upper part of glenoid cavity it blends with the origin of the long tendon of the biceps brachii. Its free margin is thinner than the attached margin. It serves to deepen the glenoid cavity.

The **Synovial Stratum** lines the interior of the articular capsule and the glenoidal labrum. It encloses the long tendon of the biceps brachii in a tubular sheath which protrudes into the intertubercular sulcus. Its protrusion beneath the subscapularis and also sometimes under cover of the infraspinatus have been already referred to.

The dissector should now carefully examine the origin of the long tendon of the biceps brachii where it is blended with the glenoidal labrum. Its course through the capsule and exit from the intertubercular sulcus should also be examined.

Movements.—The shoulder joint permits of movement in every direction—(1) flexion, (2) extension, (3) adduction, (4) abduction, (5) circumduction, or combination of the first four movements in regular succession, (6) rotation, in which the humerus revolves to the extent of quarter of a circle. Two important factors serve to weaken the mechanism of this joint: (1) the shallowness of the glenoid cavity as compared with the articulating area of the head of the humerus, and (2) the extreme looseness of the capsule which permits such free and extensive movements. But there are other provisions to counteract these defects in the mechanism of the joint. These are:—(1) The joint is surrounded on all sides by strong muscles. (2) The tendon of the long head of the biceps, on account of its position, keeps the head of the humerus in situ during the movements of the joint. (3) The coracoacromial arch prevents dislocation of the head of the humerus upwards. (4) Atmospheric pressure helps to keep the articular surfaces in contact with each other.

The **Muscles** producing the movements of the shoulder joint are:—

flexion or movement forwards—subscapularis, the **pectoralis** major and the anterior part of deltoideus;

extension or movement backwards—posterior, part of the deltoideus, latissimus dorsi and teres major;

abduction—supraspinatus and deltoideus;

adduction—subscapularis, latissimus dorsi, teres major, pectoralis major, and coracobrachialis;

rotation inwards—subscapularis, latissimus dorsi, teres major and pectoralis major;

rotation outwards—infraspinatus, teres minor and posterior fibres of deltoideus.

VOLAR ASPECT OF THE FOREARM

The skin of the volar surface of the forearm has been already reflected and the superficial fascia and the superficial veins have been examined.

The **Cutaneous Nerves** which are prolonged from the arm to the forearm have been already traced. The origins of two other cutaneous nerves just above the wrist are to be secured and their continuations into the palm will be traced during the dissection of the palm. These are: (1) the palmar cutaneous branch of the ulnar nerve which pierces the deep fascia about

an inch (2.5 cm.) above the ulnar side of the wrist; and (2) the palmar cutaneous branch of the median nerve which pierces the deep fascia just above the wrist in the median line.

The **Antibrachial Fascia** (deep fascia of the forearm) is a strong membrane which envelopes the muscles of the forearm. Above it is continuous with the brachial fascia. Above and in front it is strengthened by an expansion from the tendon of the biceps brachii called the lacertus fibrosus. Behind it is attached to the olecranon and the posterior border of the ulna and is strengthened by an expansion from the tendon of the triceps brachii. Below and in front it is thickened and continuous with the volar carpal and transverse carpal ligaments in front of the wrist. Below and behind it is thickened to form the dorsal carpal ligament which binds the extensor tendons behind the wrist. It gives origin to the muscles at the upper part of the forearm and from its deep surface septa are given off which pass between the muscles.

Dissection. Divide the deep fascia by a median longitudinal incision and a transverse cut over the wrist Reflect it preserving the two cutaneous nerves which perforate it just above the wrist. Clean the muscles on the volar aspect of the forearm These muscles are arranged in three strata: a superficial, an intermediate, and a deep. The *superficial stratum* consists of four muscles and arises by a *common tendon* from the front of the medial epicondyle of the humerus From the lateral to the medial side these are:—the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris. The intermediate stratum consists of one muscle, viz., the flexor digitorum sublimis which lies on a deeper plane partially covered by the muscles of the superficial stratum. The muscles of the deep stratum will be studied in a subsequent dissection.

The **Pronator Teres** (Pronator radii teres) arises by two heads, a humeral and an ulnar. The *humeral head* arises (1) from the anterior aspect of the medial epicondyle of the humerus by the common tendon, (2) from the antibrachial fascia covering it, and (3) from the intermuscular septum between it and the flexor carpi radialis. The *ulnar head* is deeply situated and arises from the medial side of the coronoid process of the ulna The median nerve passes between the two heads of origin. The muscle is inserted into a rough impression at the middle of the lateral surface of the radius. It is supplied by the median nerve.

It pronates the forearm and hand. It also flexes the elbow joint.

The **Flexor Carpi Radialis** arises (1) from the medial epicondyle of the humerus by the common tendon, (2) from the deep surface of the antibrachial fascia, and (3) from the intermuscular septa between it and the adjacent muscles. The muscle ends below the middle of the forearm in a tendon which runs through the lateral side of the transverse carpal ligament and along the groove on the volar surface of the greater multangular bone. It is inserted into the volar aspects of the bases of the second and third metacarpal bones—the slip to the third metacarpal bone being the smaller. The terminal portion of this tendon will be seen during the dissection of the plam. It is supplied by the median nerve. It is a flexor of the wrist and elbow joints and an abductor of the hand

The **Palmaris Longus** arises (1) from the medial epicondyle of the humerus by the common tendon, (2) from the deep surface of the antibrachial fascia, and (3) from the intermuscular septa on either side of it. It terminates in a long narrow tendon which passes over the transverse carpal ligament and is inserted into the central portion of the palmar aponeurosis It is supplied by the median nerve. It is a tensor of the palmar aponeurosis and a flexor of the wrist and elbow joints.

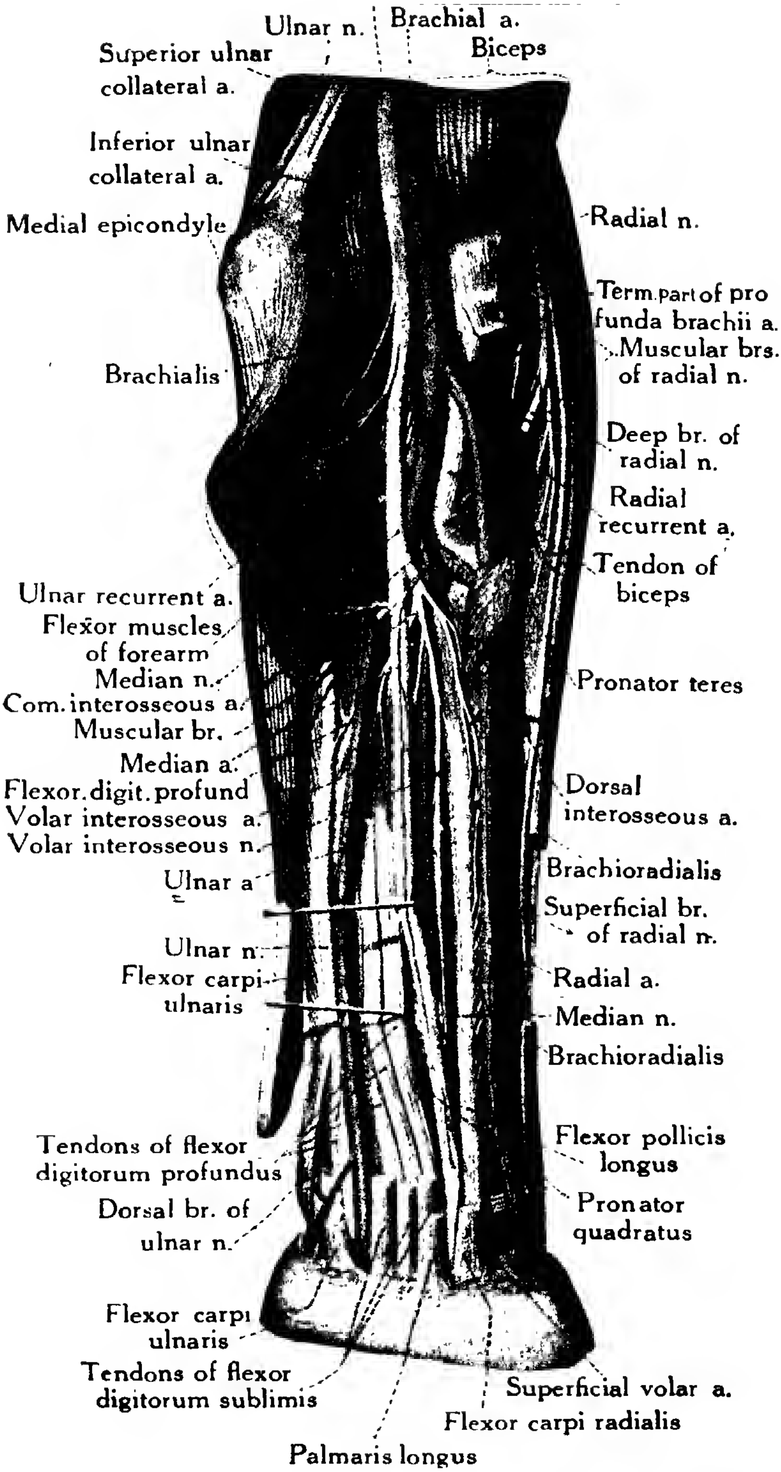
The **Flexor Carpi Ulnaris** arises (1) from the medial epicondyle of the humerus by the common tendon (humeral head), (2) from the medial border of the olecranon and the upper two-thirds of the dorsal border of the ulna (ulnar head), (3) from the deep surface of the antibrachial fascia, and (4) from the intermuscular septum between it and the flexor digitorium sublimis. The muscle terminates in a tendon which is inserted into the pisiform bone. The ulnar nerve and the dorsal ulnar recurrent artery pass between its humeral and ulnar heads. It is supplied by the ulnar nerve It is a flexor of the wrist and elbow joints and an adductor of the hand.

The **Flexor Digitorum Sublimis** is partly covered by the muscles of the superficial stratum and partly comes to the surface. To expose it fully divide the flexor carpi radialis and palmaris longus at about the middle of the forearm and reflect the proximal ends upwards separating them from the pronator teres and the flexor digitorum sublimis. The flexor digitorum sublimis arises (1) from the medial èpicondyle of the humerus by the common tendon, (2) from the medial side of the coronoid process of the

ulna, (3) from the oblique line of the radius, (4) from the ulnar collateral ligament of the elbow joint, and (5) from the intermuscular septa separating it from the other muscles of the superficial group. The fleshy mass soon divides into four tendons of which two lie superficially. These two superficial tendons are meant for the middle and ring fingers which may be ascertained by pulliig them. The other two tendons lie deep and are meant for the index and little fingers. These tendons are enclosed by a mucous sheath and pass under cover of the transverse carpal ligament to the palm. The disposition of the tendons in the palm and their mode of insertion into the phalanges will be examined during the dissection of the palm. This muscle is supplied by the median nerve. It flexes first the middle and then the proximal phalanges. It is also a flexor of the wrist and elbow joints.

Dissection. Now study the vessels and nerves exposed during the superficial dissection of the volar aspect of the forearm. These are the radial artery with its branches, the ulnar artery with its branches, the median nerve, the ulnar nerve, and the superficial branch of the radial nerve. Hook the brachioradialis laterally and trace the radial artery as it lies under cover of the muscle at the upper part of the forearm. Clean its branches. The ulnar artery is deeply placed in the upper part of the forearm. To expose it divide the radial head of the flexor digitorum sublimis and hook the muscle medially. Look for the common interosseous branch of the ulnar artery in the cubital fossa and trace its volar interosseous branch in front of the interosseous membrane along the contiguous borders of the flexor pollicis longus and the flexor digitorum profundus. Note that the volar interosseous branch of the median nerve accompanies the artery. Trace both to the upper border of the pronator quadratus. The median nerve is now well exposed as it issues from between the two heads of the pronator teres. Trace its branches to the muscles.

The **Radial Artery** begins in the cubital fossa at the bifurcation of the brachial artery opposite the neck of the radius. It descends along the radial side of the volar aspect of the forearm up to the wrist and then winds round its lateral border to reach the dorsum of the hand where it will be examined subsequently. In the upper part of the forearm it is covered by the fleshy portion of the brachioradialis and is placed between this muscle and the pronator teres but lower down it is superficial being covered


Ulnar n.
Brachial a.
Biceps
Superior ulnar collateral a.
Inferior ulnar collateral a.
Medial epicondyle
Radial n.
Term. part of profunda brachii a.
Muscular brs. of radial n.
Brachialis
Deep br. of radial n.
Radial recurrent a.
Tendon of biceps
Ulnar recurrent a.
Flexor muscles of forearm
Median n.
Com. interosseous a.
Muscular br.
Median a.
Flexor. digit. profund
Volar interosseous a.
Volar interosseous n.
Pronator teres
Dorsal interosseous a.
Brachioradialis
Ulnar a
Superficial br. of radial n.
Ulnar n.
Flexor carpi ulnaris
Radial a.
Median n.
Brachioradialis
Tendons of flexor digitorum profundus
Flexor pollicis longus
Dorsal br. of ulnar n.
Pronator quadratus
Flexor carpi ulnaris
Tendons of flexor digitorum sublimis
Superficial volar a.
Flexor carpi radialis
Palmaris longus

by the skin and fasciæ and lies between the tendons of the brachioradialis and flexor carpi radialis. Owing to its superficial position above the wrist the pulse is usually felt in the radial artery at this situation. Its posterior relations from above downwards are : the tendon of the biceps brachii, the supinator, the insertion of the pronator teres, the radial origin of the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus, and the lower end of the radius. The superficial branch of the radial nerve is placed close to the lateral side of the artery in the middle third of the forearm. The radial artery is accompanied by the *venæ comitantes* throughout its entire course.

Branches.—The radial artery gives of the following branches in the forearm :—(1) The *radial recurrent artery*. It arises from the commencement of the radial artery and passes lateralwards upon the supinator muscle. Then it ascends between the brachialis and the brachioradialis to anastomose with the terminal portion of the arteria profunda brachii. It supplies the neighbouring muscles. (2) The *volar carpal branch*. It arises opposite the lower border of the pronator quadratus and passes medialwards beneath the flexor tendons to anastomose with the volar carpal branch of the ulnar artery. (3) The *superficial volar branch*. It arises from the radial artery before this vessel winds round the wrist. In the palm it passes either across or through the short muscles of the thumb. It may end in those muscles or may continue its course to join the lateral end of the superficial volar arch. (4) The *muscular branches*. These are many twigs which supply the muscles on the lateral side of the volar aspect of the forearm.

The **Ulnar Artery** begins at the bifurcation of the brachial and is larger than the radial artery. At first it runs obliquely downwards and medialwards and reaches the ulnar side of the forearm. Then it descends straight downwards to the wrist, passes across the front of the medial end of the transverse carpal ligament, and enters the palm. It is accompanied by two *venæ comitantes*.

Observe the *relations of the proximal oblique portion* of the artery. It is deeply placed lying underneath the pronator teres, the flexor carpi radialis, the palmaris longus and the flexor digitorum sublimis. The median nerve crosses the artery from the medial to the lateral side, the ulnar head of the pronator teres intervening between them. The ulnar nerve is not in immediate relation with the oblique portion of the artery, but gains

its medial side at the commencement of its vertical course. Posteriorly the oblique portion of the artery rests on the brachialis and the flexor digitorum profundus.

Now study the *relations of the distal vertical portion* of the artery. In the upper part it is covered by the flexor carpi ulnaris. Lower down a little above the wrist it is superficial being covered only by the skin and the superficial and deep fasciæ and is placed between the tendon of the flexor carpi ulnaris medially and the tendons of the flexor digitorum sublimis laterally. The ulnar nerve lies close to the medial side of the artery in the lower two-thirds of the forearm. Posteriorly the artery lies upon the flexor digitorum profundus and at the wrist upon the transverse carpal ligament.

Branches.—The ulnar artery gives off the following branches in the forearm :—(1) The *volar ulnar recurrent artery*. It is given off from the ulnar artery soon after its origin. It passes upwards between the pronator teres and the brachialis, supplies these muscles and anastomoses with the superior and inferior ulnar collateral artery in front of the medial epicondyle of the humerus. (2) The *dorsal ulnar recurrent artery*. It is larger and arises a little below the preceding or sometimes by a common trunk with that branch. It passes medialwards and backwards beneath the flexor digitorum sublimis and then ascends along the interval between the medial epicondyle of the humerus and the olecranon to anastomose with the superior and inferior ulnar collateral arteries. It supplies the neighbouring muscles and the elbow joint. (3) The *common interosseous artery*. It is a short thick trunk and arises below the preceding branch and passes backwards to reach the upper border of the interosseous membrane of the forearm where it divides into a volar and dorsal branch. These will be traced later on. (4) The *volar carpal branch* (anterior carpal). It runs lateralwards in front of the carpus beneath the flexor tendons and anastomoses with the volar carpal branch of the radial artery forming an anastomotic arch or network. (5) The *dorsal carpal branch*. It arises above the pisiform bone and winds round the medial border of the wrist. It will be traced during the dissection of the dorsum of the forearm. (6) The *muscular branches* supply the muscles of the ulnar side of the forearm.

The **Radial Nerve** has been seen to divide into a superficial and a deep branch under cover of the brachioradialis where it forms the lateral boundary of the cubital fossa. The *superficial*

branch of the radial nerve (radial nerve) runs downwards over the supinator covered by the brachioradialis. It accompanies the radial artery lying on its lateral side in the upper two-thirds of its course. It then quits the artery and winds round the lateral side of the forearm to reach its dorsal aspect, where it will be studied later on. The *deep branch* of the radial nerve (posterior interosseous nerve) winds rounds the lateral side of the radius through the substance of the supinator to reach the dorsal aspect of the forearm. It will be subsequently examined.

The **Median Nerve** enters the forearm between the two heads of the pronator teres. It is necessary that the dissector should cut the humeral head of the muscle so that the nerve may be traced in its entirety in the forearm. Its relation to the ulnar artery has been noted. In the forearm it runs downwards under cover of the flexor digitorum sublimis and in front of the flexor digitorum profundus. About two inches (5 cm.) above the wrist it becomes superficial and lies between the tendons of the flexor digitorum sublimis medially and the tendon of the flexor carpi radialis laterally. It then passes behind the transverse carpal ligament to the palm of the hand. The arteria mediana, which is derived from the volar interosseous artery accompanies the median nerve in the forearm. The *branches* given off from the median nerve in the forearm are: (1) *muscular branches* to the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor digitorum sublimis; (2) the *palmar cutaneous branch* which has already been secured near the wrist; and (3) the *volar interosseous nerve* which is distributed to the deep muscles on the front of the forearm.

Ulnar Nerve. The course of this nerve in the arm has been studied (p. 501). It lies in the sulcus nervi ulnaris on the back part of the medial epicondyle of the humerus and passes into the forearm between the two heads of origin of the flexor carpi ulnaris. It descends along the volar aspect of the ulnar side of the forearm being covered by the flexor carpi ulnaris and is placed upon the flexor digitorum profundus. Near the wrist it becomes superficial being covered by the skin and the fasciæ and lies on the lateral side of the tendon of the flexor carpi ulnaris. It then passes over the transverse carpal ligament and reaches the palm of the hand. Its relation to the ulnar artery has been already described. The *branches* of the ulnar nerve in the forearm are;—(1) *articular branches* which arise from the nerve as it lies between the medial epicondyle and the olecranon and enter the elbow

joint; (2) *muscular branches* which supply the flexor carpi ulnaris and the medial half of the flexor digitorum profundus; (3) the *palmar cutaneous branch* which springs about the middle of the forearm, descends in front of the ulnar artery and perforates the deep fascia about an inch above the wrist; and (4) the *dorsal branch* which issues about two inches above the wrist and passes to the dorsum of the forearm by winding round its ulnar side under cover of the flexor carpi ulnaris.

Now study the *deep group* of muscles on the front of the forearm. These are the flexor digitorum profundus on the ulnar side, the flexor pollicis longus on the radial side and the pronator quadratus which is placed beneath these two muscles above the wrist over both bones of the forearm. The volar interosseous vessels and nerve lying in front of the interosseous membrane of the forearm between the flexor digitorum profundus and the flexor pollicis longus are also to be studied.

The **Flexor Digitorum Profundus** arises (1) from the upper three-fourths of the volar and medial surfaces of the body of the ulna; (2) from a depression on the medial side of the coronoid process; (3) from the ulnar side of the volar aspect of the interosseous membrane; and (4) from the dorsal border of the body of the ulna by an aponeurosis common to it and the flexor carpi ulnaris. The muscle divides into four tendons which psss beneath the transverse carpal ligament to the palm. It should be noted that of the four tendons the tendon for the index finger becomes separate from the others in the forearm. The lateral half of the muscle is supplied by the volar interosseous branch of the median nerve and the medial half by the ulnar nerve. It flexes the terminal phalanges. It flexes the other phalanges also in conjunction with the flexor digitorum sublimis; it is also a flexor of the wrist joint.

The **Flexor Pollicis Longus** arises (1) from the volar surface of the radius, extending from the oblique line above to the upper margin of the pronator quadratus below; (2) from the radial side of the volar aspect of the interosseous membrane; and occasionally (3) from the medial margin of the coronoid process. The muscle ends in a tendon which passes beneath the transverse carpal ligament to the palm. It is supplied by the volar interosseous branch of the median nerve. It is a flexor of the joints of the thumb and of the wrist.

The **Pronator Quadratus** covers the lower part of the volar aspects of the radius and ulna. It arises from the pronator

ridge and from the adjacent volar surface of the lower part of the ulna. It is inserted into the volar surface of the lower fourth of the radius as far as the lateral border of the bone. The deep fibres are inserted into the triangular rough area above the ulnar notch of the radius. It is supplied by the volar interosseous nerve which enters its deep surfae. It is a pronator of the forearm—with the result that the palm of the hand looks backwards.

Volar Interosseous Artery (Anterior interosseous artery).—Its origin from the common interosseous branch of the ulnar artery has been noticed. It descends along the volar aspect of the interosseous membrane lying between the flexor digitorum profundus medially and the flexor pollicis longus laterally. At the upper margin of the pronator quadratus it perforates the interosseous membrane and reaches the dorsal aspect of the forearm where it anastomoses with the dorsal interosseous artery—this anastomosis will be seen later on. It gives off: (1) *muscular branches* to the three deep muscles of the front of the forearm; (2) *nutrient branches* to the radius and ulna; (3) the *arteria mediana* which accompanies the median nerve and supplies it—it occasionally terminates in the superficial volar arch; and (4) the *volar communicating branch* which issues before the artery pierces the interosseous membrane and descends under cover of the pronator quadratus to join the volar carpal network.

Dissection. To expose the volar communicating branch of the volar interosseous artery and the termination of the volar interosseous nerve behind the pronator quadratus cut through the muscle vertically in the middle line. Trace the artery and nerve as they lie under cover of the muscle.

Volar Interosseous Nerve (Anterior interosseous nerve).—Its origin from the median nerve has been noted. It accompanies the volar interosseous artery on the volar aspect of the interosseous membrane and supplies the flexor pollicis longus and the lateral half of the flexor digitorum profundus. It then passes behind the pronator quadratus, supplies twigs to it and terminates in the wrist joint.

DORSUM AND LATERAL SIDE OF THE FOREARM AND DORSUM OF THE WRIST AND HAND

Dissection. Place the limb on its volar aspect and put a small block beneath the wrist with the object of stretching the

tendons. Remove the skin from the back of the forearm (if not already removed). To reflect the skin from the dorsum of the hand make a curved incision along the roots of the fingers and thumb. From the centre of this make a longitudinal incision to meet the transverse cut above the wrist. The skin should also be reflected from the dorsal aspects of the thumb and other fingers by making a median longitudinal incision over each of them.

Cutaneous Nerves.—The following cutaneous nerves on the back of the forearm have been already noted:—(1) The ulnar branch of the medial antibrachial cutaneous nerve which encroaches on the ulnar side of the dorsum of the forearm from its medial aspect ; (2) some twigs from the lateral antibrachial cutaneous nerve which encroaches on the radial side of the back of the forearm from its lateral aspect ; (3) the lower branch of the dorsal antibrachial cutaneous nerve which descends along the middle of the dorsum of the forearm as far as the wrist. Two other nerves require to be examined : (1) The *dorsal branch of the ulnar nerve* appears on the ulnar side of the dorsum of the forearm by winding round its medial border under cover of the flexor carpi ulnaris about two inches above the wrist. Piercing the deep fascia it descends along the ulnar side of the dorsum of the wrist and hand. It then divides into two dorsal digital branches and a communicating branch. Of the two *dorsal digital branches*, one supplies the medial margin of the dorsum of the hand and the little finger ; the other is distributed to the contiguous sides of the little and ring fingers on the dorsal aspect. But they do not supply the dorsal aspects of the terminal phalanges, which receive twigs from the proper digital branches of the ulnar nerve on the volar aspect. The *communicating branch* joins the twig from the superficial branch of the radial nerve which supplies the contiguous sides of the ring and middle fingers on their dorsal aspects. (2) The *superficial branch of the radial nerve* has been traced to the point where it turns round the radial side of the forearm at the junction of its lower and middle thirds under cover of the brachioradialis to gain the dorsal aspect. It then pierces the deep fascia and divides into a lateral and a medial branch. The *lateral branch* is the smaller and is distributed to the skin of the radial border of the hand and the thumb and communicates with the volar branch of the lateral antibrachial cutaneous nerve. The *medial branch* divides into four dorsal digital branches : the first supplies the ulnar side of the thumb ;

the second, the radial side of the index finger; the third, the contiguous sides of the index and middle fingers; and the fourth, the adjoining sides of the middle and ring fingers. These dorsal digital nerves do not supply the dorsal aspects of the terminal phalanges which receive twigs from the proper volar digital branches of the median nerve on the volar aspect. The fourth digital branch is joined by the communicating filament from the dorsal branch of the ulnar nerve.

Superficial Veins.—Two *dorsal digital veins*, one along the radial and one along the ulnar border, pass over the dorsum of each digit. The dorsal digital veins of the thumb terminate in the cephalic vein. The dorsal digital vein on the ulnar side of the little finger ends in the basilic vein. The remaining dorsal digital veins unite and form, opposite the heads of the metacarpal bones, three *dorsal metacarpal veins*. These three veins join with each other and form opposite the middle of the metacarpus, the *dorsal venous arch*. From the radial end of this venous arch the *cephalic vein* commences and from the ulnar

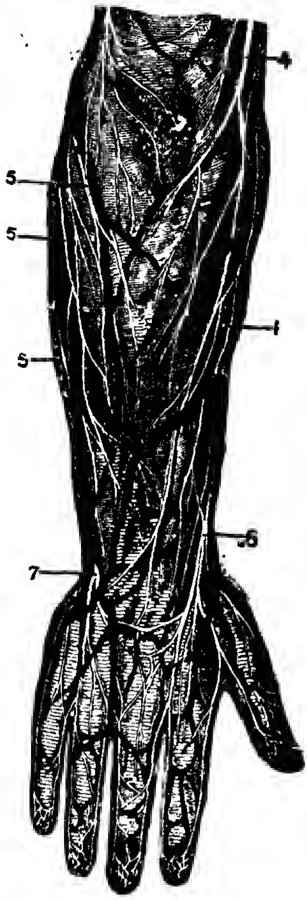


Fig. 158.—Cutaneous dissection of the back of the forearm and dorsum of the hand (from Hirschfeld and Leveille).

1′ Venous arch on the dorsum of the hand.
1. Cephalic vein.
4. Dorsal antibrachial cutaneous branch of radial nerve.
5. Ulnar branch of medial antibrachial cutaneous nerve.
6. Superficial branch of radial nerve.
7. Dorsal branch of ulnar nerve.

side of it the *basilic vein* takes origin. The cephalic vein winds round the radial border and the basilic vein round the ulnar border of the forearm and both reach its volar aspect.

Dissection. Remove the deep fascia carefully, noting that the superficial muscles take their origin from the deep surface of the fascia. Preserve the thickened band of the fascia on the dorsum of the wrist which forms the dorsal carpal ligament. Clean the tendons on the dorsum of the hand and define the slips passing from the tendon of the ring finger to the tendons for the middle and little fingers. Note that on the dorsum of the proximal phalanx of each finger the extensor tendon expands. Trace this *expansion* in one of the fingers and note that opposite the base of the second phalanx it splits into three slips—the intermediate slip is inserted into the base of the second phalanx and the two collateral slips reunite to be inserted into the base of the terminal phalanx. Pull the expansion and note that it receives on either side (except over the little finger) the insertions of lumbrical and interossei muscles. The superficial group of muscles on the lateral side and dorsum of the forearm are now to be studied. These muscles are described below from the radial to the ulnar side of the forearm.

The **Brachioradialis** (supinator longus) arises from the upper two-thirds of the lateral supracondylar ridge of the humerus and from the lateral intermuscular septum attached to it. It ends in a flat tendon at about the middle of the forearm and is inserted into the antero-lateral aspect of the base of the styloid process of the radius. It is supplied by a branch from the radial nerve. It is a flexor of the elbow joint ; if the forearm is already pronated it can help to supinate ; if the forearm is already supinated it can help to pronate.

The **Extensor Carpi Radialis Longus** arises from the lower third of the lateral supracondylar ridge of the humerus and from the lateral intermuscular septum. The muscle terminates at about the junction of the upper with the middle third of the forearm in a tendon which passes under cover of the dorsal carpal ligament to be inserted into the dorsal surface of the base of the second metacarpal bone. It is supplied by the radial nerve. It is an extensor of the wrist and to a slight extent an abductor of the hand.

The **Extensor Carpi Radialis Brevis** arises (1) from the lateral epicondyle of the humerus by the common tendon of origin of four extensor muscles, (2) from the radial collateral ligament of the elbow joint, (3) from the deep fascia covering it, and (4) from the intermuscular septa separating it from the adjacent muscles. It ends about the middle of the forearm in a tendon,

which passes under cover of the dorsal carpal ligament in the same compartment with the extensor carpi radialis longus and enclosed in one mucous sheath. It is inserted into the dorsal aspect of the base of the third metacarpal bone. It is supplied by the deep branch of the radial nerve. It is an extensor of the wrist and of the elbow.

The **Extensor Digitorum Communis** arises (1) from the lateral epicondyle of the humerus by the common tendon, (2) from the deep fascia of the forearm, and (3) from the intermuscular septa between it and the adjacent muscles. At the lower third of the forearm it divides into four tendons which pass under

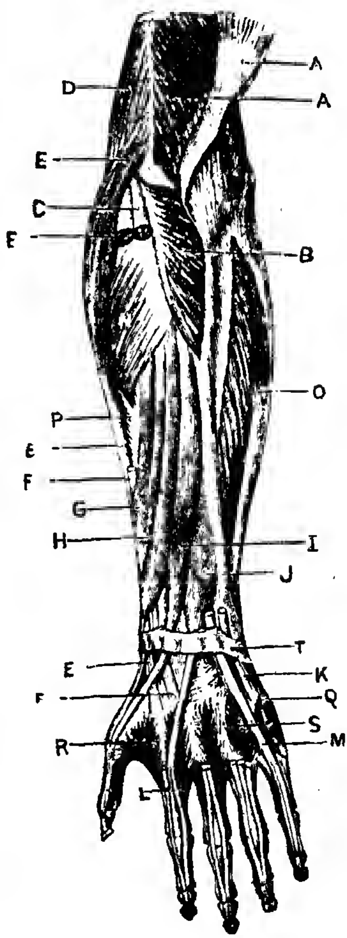


Fig. 159.—Muscles of the back of the forearm (from Sappey).

A. Triceps brachii.
B. Anconæus.
C. Common tendon of extensor digitorum communis, extensor digiti quinti proprius and extensor carpi ulnaris.
D. Brachioradialis.
E. Extensor carpi radialis longus.
F. Extensor carpi radialis brevis.
G. Abductor pollicis longus.
H. Extensor pollicis brevis.
I. Extensor pollicis longus
J. Extensor indicis proprius.
K. Insertion of extensor carpi ulnaris.
L. Dorsal expansion of extensor digitorum communis and extensor indicis proprius.
M. Tendon of extensor digiti quinti proprius.
N. Supinator.
O. Tendon of flexor carpi ulnaris.
P. Insertion of pronator teres.
Q. Abductor digiti quinti.
R. First dorsal interosseous.
S. Fourth dorsal interosseous muscle
T. Dorsal carpal ligament.

cover of the dorsal carpal ligament in the same compartment with the extensor indicis proprius and enclosed in one mucous sheath. On the dorsum of the hand the four tendons diverge from each other and proceed to the dorsal aspects of the four fingers. The tendon for the index finger is joined on its ulnar side by the tendon of the extensor indicis proprius. The tendon for the little finger is joined on its ulnar side by the tendon of the extensor digiti quinti proprius. The tendons for the middle and ring fingers run singly. Each tendon covers the dorsal aspect of the metacarpophalangeal articulation and spreads over the whole of the dorsum of the first phalanx, into an *expansion* which receives the insertions of the corresponding tendons of the lumbricalis and interossei. At the base of the second phalanx each tendon divides into three slips, one intermediate and two collateral. The *intermediate slip* is inserted into the dorsum of the base of the second phalanx. The *collateral slips* converge over the dorsum of the second phalanx and reunite to form one slip which is inserted into the dorsum of the base of the last phalanx. Over the lower part of the dorsum of the hand the tendon to the ring finger is connected on either side with the tendons to the middle and little fingers by oblique flattened tendinous bands. Sometimes the tendon to the middle finger is also similarly connected with the tendon to the index finger. The muscle is supplied by the deep branch of the radial nerve. It is an extensor of all the phalanges and also of the wrist and of the elbow.

The **Extensor Digiti Quinti Proprius** (extensor minimi digiti) arises from the lateral epicondyle of the humerus by the common tendon and from the intermuscular septa between it and the adjacent muscles. The muscle ends in a tendon which passes through a separate compartment of the dorsal carpal ligament and divides over the dorsum of the hand into two slips, both of which ultimately blend with the expanded tendon of the extensor digitorum communis for the little finger over the dorsum of its first phalanx. It is supplied by the deep branch of the radial nerve. It is an extensor of the little finger and also a feeble extensor of the wrist and elbow.

The **Extensor Carpi Ulnaris** arises (1) from the lateral epicondyle of the humerus by the common tendon, (2) from the deep fascia, (3) from the intermuscular septum separating it from the preceding muscle, and (4) from the dorsal border of the ulna by an aponeurosis. It ends in a tendon which passes through

a separate compartment of the dorsal carpal ligament along the groove between the head and styloid process of the ulna. Here it is lined by a mucous sheath. It is inserted into the tubercle on the medial side of the base of the fifth metacarpal bone. The muscle is supplied by the deep branch of the radial nerve. It is an extensor of the wrist and of the elbow and an adductor of the hand.

The **Anconæus** is a triangular muscle which is narrow at its origin but is broad at its insertion. It arises from the back part of the lateral epicondyle of the humerus and is inserted into the lateral surface of the olecranon and into the upper fourth of the dorsal surface of the body of the ulna. It is supplied by a long slender twig derived from the radial nerve which passes through the substance of the medial head of the triceps and then reaches the muscle. It extends the elbow joint.

Dissection. Now study the muscles of the deep group and the dorsal interosseous artery and nerve The muscles of the deep group are the supinator, the abductor pollicis longus, the extensor pollicis brevis, the extensor pollicis longus, and the extensor indicis proprius. Divide the brachioradialis, extensores carpi radialis longus and brevis, the extensor digitorum communis and the extensor digiti quinti proprius through their fleshy bellies before they terminate in tendons and reflect them without injuring the nerves which supply them. Throw the proximal portions of the divided muscles towards their origins and the distal portions towards their insertions and fix them with hooks. Hook the fleshy mass of extensor carpi ulnaris medially. The muscles of the deep group and the dorsal interosseous artery and nerve are exposed. First trace the dorsal interosseous artery from the upper border of the interosseous membrane between the superficial and deep group of muscles to its termination on the dorsum of the wrist and find its branches. Secure the terminal part of the volar interosseous artery as it appears at the lower part of the dorsum of the forearm by perforating the interosseous membrane. Note that it ends by joining the dorsal carpal network at the back of the wrist. Next find the radial artery as it lies on the lateral part of the dorsum of the wrist and secure its three branches given at this stage. Now look for the deep branch of the radial nerve. Secure its branches to the extensor carpi radialis brevis and supinator which are given off before it reaches the dorsum of the forearm. Trace the

nerve as it passes through the substance of the supinator and when it quits that muscle find the branches given off from it to the extensor digitorum communis, extensor digiti quinti proprius and extensor carpi ulnaris. Next secure the branches given off from it to the deep muscles, viz., the extensor pollicis longus, extensor indicis proprius, abductor pollicis longus and extensor pollicis brevis. The nerve now assumes the name of the dorsal interosseous nerve and lies on the antibrachial interosseous membrane and presents a gangliform swelling on the dorsum of the wrist from which twigs are given off to the wrist joint.

The **Supinator** (supinator brevis) consists of a superficial layer and a deep layer between which the deep branch of the radial nerve passes. Both the layers arise (1) from the lateral epicondyle of the humerus, (2) from the radial collateral ligament of the elbow-joint, (3) from the annular ligament of the proximal radioulnar articulation, (4) from the ridge on the ulna which proceeds from the radial notch, and (5) from the triangular depression below the radial notch of the ulna. The fibres of muscle turn round the neck and the upper part of the body of the radius and are inserted into the oblique line of the radius and to the lateral and dorsal surfaces of the body of the bone above the oblique line. It is supplied by the deep branch of the radial nerve which passes through it. It supinates the forearm i.e., rotates so that the palm of the hand looks forwards.

The **Abductor Pollicis Longus** (extensor ossis metacarpi pollicis) arises (1) from the lateral part of the dorsal surface of the body of the ulna below the oblique ridge, (2) from the middle third of the dorsal surface of the body of the radius, and (3) from the interosseous membrane. It passes downwards and lateralwards, crosses the tendons of the extensores carpi radialis longus and brevis and ends in a tendon which passes under cover of the dorsal carpal ligament in the same compartment with the extensor pollicis brevis on the lateral side of the lower end of the radius. It is inserted into the lateral side of the base of the first metacarpal bone. The muscle is supplied by the deep branch of the radial nerve. It is an abductor of the thumb and hand.

The **Extensor Pollicis Brevis** (extensor primi internodii pollicis) arises from the dorsal surface of the body of the radius below the preceding muscle and from the adjacent interosseous membrane. It accompanies the abductor pollicis longus

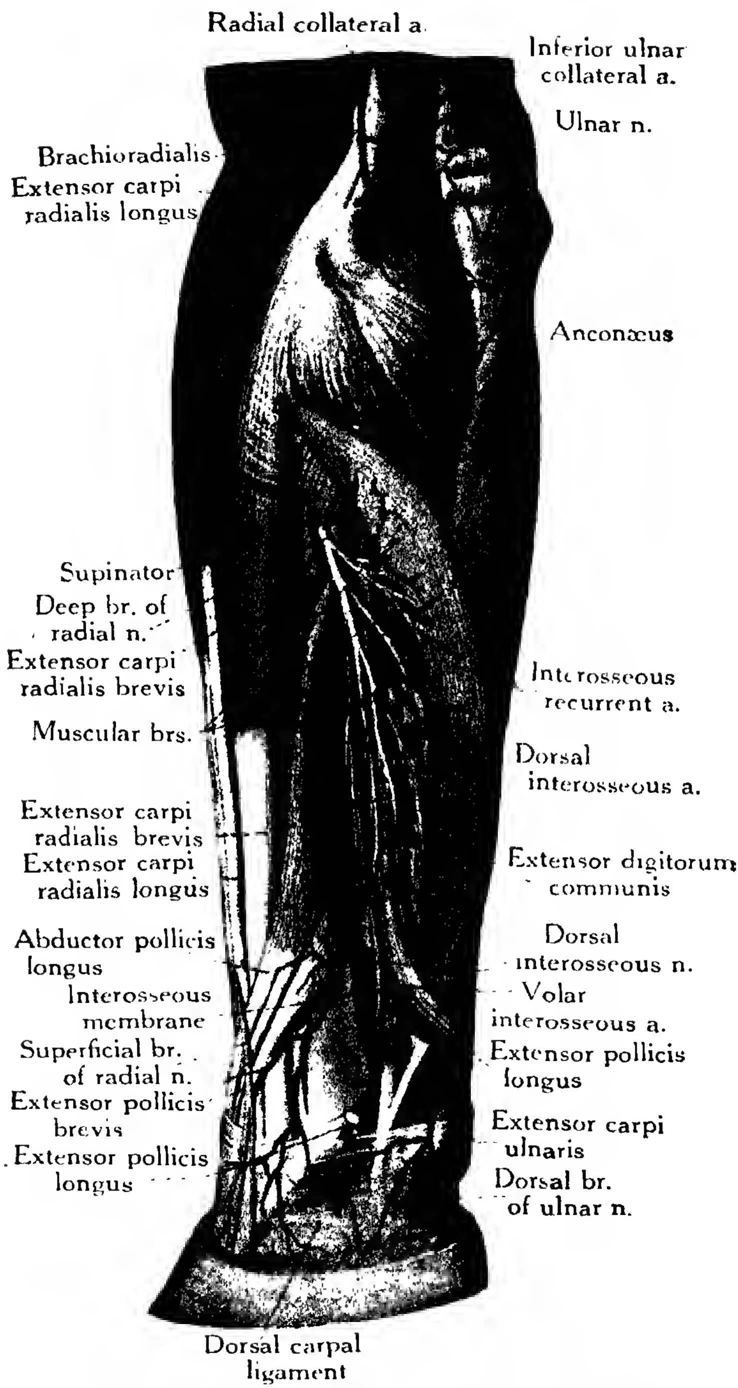


Fig. 160.—Dissection of the dorsum of the forearm (Sobotta).

and its tendon passes through the same compartment of the dorsal carpal ligament. It is inserted into the dorsum of the base of the first phalanx of the thumb. It is supplied by the deep branch of the radial nerve. It is an extensor of the proximal phalanx of the thumb; it is also an extensor of the wrist and abductor of the hand.

The **Extensor Pollicis Longus** (extensor secundi internodii pollicis) arises from the lateral part of the dorsal surface of the body of the ulna below the origin of the abductor pollicis longus and from the adjacent interosseous membrane. Its tendon passes under cover of the dorsal carpal ligament through a separate compartment. It is inserted into the dorsal aspect of the base of the last phalanx of the thumb. It is supplied by the deep branch of the radial nerve. It is an extensor of the terminal phalanx of the thumb. It is also an extensor of the wrist and an abductor of the hand.

The **Extensor Indicis Proprius** arises from the lateral part of the dorsal surface of the body of the ulna below the origin of the preceding muscle and from the lower part of the interosseous membrane. Its tendon passes with those of the extensor digitorum communis under cover of the dorsal carpal ligament. The tendon is ultimately blended, opposite the metacarpophalangeal articulation, with the tendon of the common extensor of the digits to the index finger. It is supplied by the deep branch of the radial nerve. It is an extensor of the index finger and a feeble extensor of the wrist.

Dorsal Interosseous Artery (Posterior interosseous artery).—Its origin from the common interosseous artery on the volar aspect of the forearm has been observed (p. 514). It passes backwards between the upper border of the antibrachial interosseous membrane and the oblique cord and appears on the dorsum of the forearm between the supinator and the abductor pollicis longus. It descends between the superficial and deep groups of muscles to the dorsum of the wrist where it anastomoses with the terminal part of the volar interosseous artery and with the dorsal carpal branches of the radial and ulnar arteries. The *branches* given off from it are :—(1) The ***interosseous recurrent*** which arises as soon as the parent trunk appears on the dorsum of the forearm. It ascends under cover of the anconæus to the interval between the lateral epicondyle of the humerus and the olecranon to anastomose with the radial collateral branch of the arteria profunda brachii and with the inferior ulnar collateral

artery. Hence the artery has to be traced by cutting through the substance of the anconæus. (2) *Muscular branches* which supply the neighbouring muscles.

Deep Branch of the Radial Nerve.—The origin of this nerve in front of the forearm has been seen (p. 515). It gains the dorsum of the forearm by passing between the superficial and deep planes of the supinator. It then descends between the superficial and deep groups of muscles to the upper margin of the extensor pollicis longus. Being much reduced in size by giving off all its muscular branches it passes in front of the extensor pollicis longus and descends on the dorsal aspect of the interosseous membrane as the **dorsal interosseous nerve** to the dorsum of the carpus lying in the same compartment of the dorsal carpal ligament with the extensor digitorum communis and extensor indicis propius. Here it terminates in a gangliform enlargement like that seen on the nerve to the teres minor and from this enlargement twigs are given off to the wrist joint. Before the the deep branch of the radial nerve gains the dorsum of the forearm it supplies branches to the extensor carpi radialis brevis and the supinator. On the dorsum of the forearm it supplies the remaining muscles, viz., the extensor digitorum communis, extensor digiti quinti proprius, extensor carpi ulnaris, abductor pollicis longus, the two extensors of the thumb, and the extensor indicis proprius.

The **Volar Interosseous Artery** has been traced to the upper border of the pronator quadratus where it perforates the interosseous membrane to gain the dorsum of the forearm. Then it descends on the back of the carpus and anastomoses with the terminal part of the dorsal interosseous artery and with the arch formed by the dorsal carpal branches of the radial and ulnar arteries.

The **Radial Artery** has been traced in front of the forearm as far down as the wrist. Here it winds backwards round the radial border of the carpus lying upon the radial collateral ligament of the wrist joint and covered by the abductor pollicis longus and extensor pollicis brevis. It then descends upon the navicular and greater multangular bones and, reaching the proximal end of the first interosseous space, dips between the two heads of the first dorsal interosseous muscle to join the deep volar arch in the palm. It is accompanied by two venæ comitantes. At this stage of the dissection it gives off the following *branches*:—(1) The *dorsal carpal*

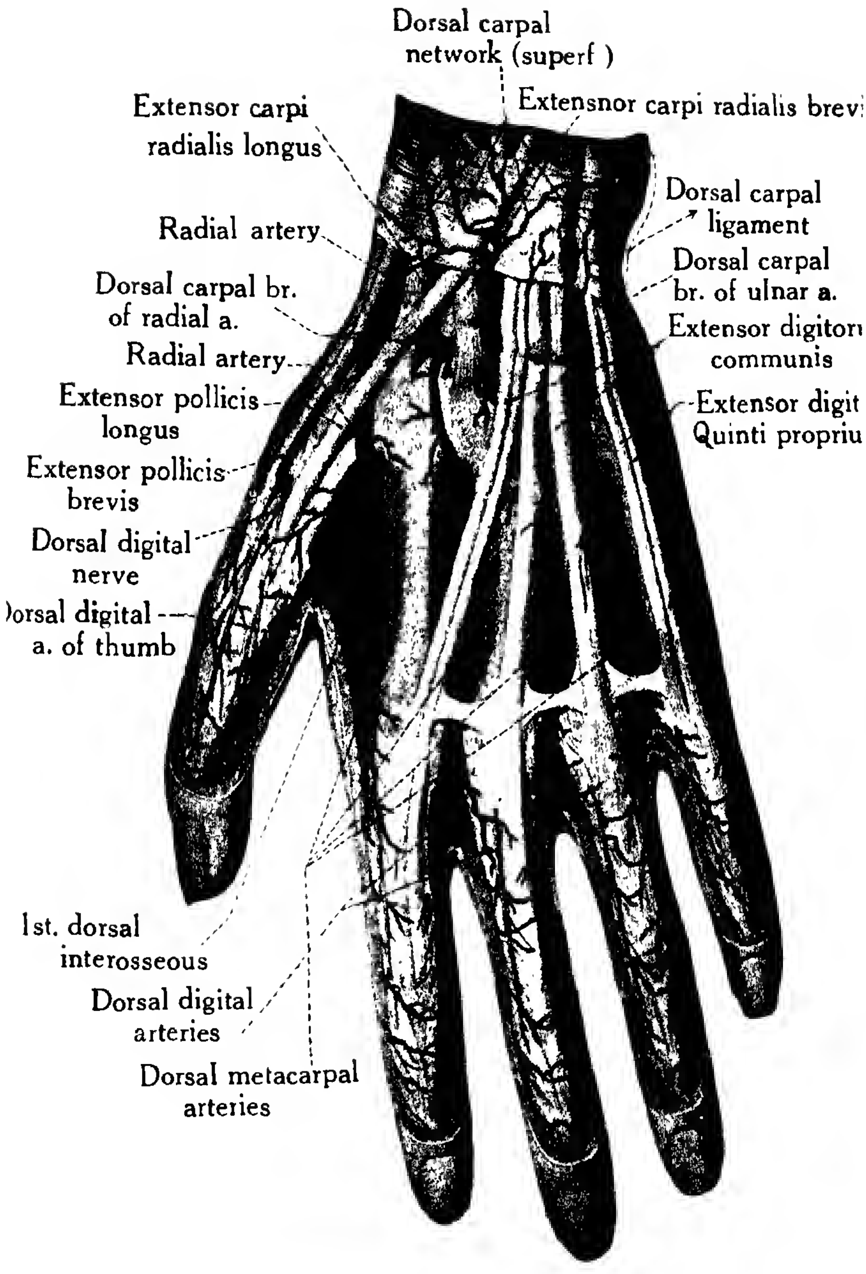


Fig. 161.—Dissection of the dorsum of the hand and wrist (Sobotta).

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artery which arises from the radial artery where it is crossed by the abductor pollicis longus and extensor pollicis brevis. It passes medialwards along the dorsum of the carpus to anastomose with the dorsal carpal branch of the ulnar artery and with the dorsal and volar interosseous arteries. (2) A *dorsal digital branch* arises from the artery and supplies the radial side of the dorsal aspect of the thumb. (3) The *first dorsal metacarpal artery*. It arises from the radial artery just before it dips into the palm. It soon bifurcates into two dorsal digital branches which supply the contiguous sides of the thumb and index finger on their dorsal aspects.

The **Dorsal Carpal Network** or **Arch** is formed on the dorsum of the carpus by the anastomosis of the dorsal carpal branches of the radial and ulnar arteries. This anastomotic arch is joined from above by the terminal portions of the volar and dorsal interosseous arteries. The *second, third* and *fourth dorsal metacarpal arteries* are given off from this network which descend along the second, third and fourth intermatacarpal spaces respectively. Each divides into two *dorsal digital branches*. Those of the second supply the contiguous sides of the index and middle fingers on their dorsal aspects. Those of the third supply the contiguous sides of the middle and ring fingers. Those of the fourth supply the contiguous sides of the ring and little fingers. These dorsal metacarpal arteries are joined by the superior perforating branches of the deep volar arch which emerge between the heads of the dorsal interosseous muscles at the proximal parts of the interosseous spaces. They also communicate with the common volar digital branches of the superficial volar arch by *inferior perforating branches* which pass between the heads of the metacarpal bones

The **Dorsal Carpal Ligament** (posterior annular ligament) is a thickened portion of the deep fascia of the forearm which stretches as a strong fibrous band across the dorsum of the wrist and keeps the tendons in situ. Laterally it is attached to the lateral margin of the lower end of the radius and medially to the styloid process of the ulna and to the triquetral and pisiform bones. From its deep surface processes are given off which are attached to the ridges on the back part of the lower end of the radius so as to form six osseo-fibrous compartments for the tendons on the dorsum of the wrist. Each of these compartments is lined by a separate mucous sheath which encloses the tendon or tendons passing through it. Open up each of these compart-

ments and examine them from the lateral to the medial side. The *first* compartment is on the lateral side of the styloid process of the radius and contains the tendons of the abductor pollicis longus and extensor pollicis brevis. The *second* compartment is on the lateral side of the dorsum of the lower end of the radius and contains the tendons of the extensores carpi radiales longus and brevis. The *third* compartment is formed by the narrow groove directed obliquely downwards and lateralwards about the middle of the back of the lower end of the radius and contains the tendon of the extensor pollicis longus. The *fourth* compartment is broad and shallow and situated to the medial side of the preceding; it contains the tendons of the extensor digitorum communis and extensor indicis proprius. The *fifth* compartment is over the interval between the lower ends of the radius and ulna and contains the tendon of the extensor digiti quinti proprius. The *sixth* compartment corresponds to the groove on the dorsal aspect of the lower end of the ulna between its head and styloid process; it contains the tendon of the extensor carpi ulnaris.

Anastomosis around the elbow joint.—The student has studied the arterial anastomosis which takes place around the elbow joint at different stages of dissection. As this arterial anastomosis is very rich and important he should study it as a whole all around the joint. This anastomosis may be divided into five distinct sets according to their position: of these anastomoses four are vertical and situated symmetrically in front of and behind both the epicondyles of the humerus, the fifth is a transverse arterial arch above the olecranon fossa of the humerus. *In front* of the medial epicondyle, the anastomosing arteries are the volar ulnar recurrent artery and the anterior branches of the superior and inferior ulnar collateral arteries, *behind* the medial epicondyle, the dorsal ulnar recurrent and the superior and inferior ulnar collateral arteries inosculate. In *front* of the lateral epicondyle the anastomosing arteries are the radial recurrent and the arteria profunda brachii; *behind* the lateral epicondyle the interosseous recurrent, the inferior ulnar collateral, and the radial collateral branch of the arteria profunda brachii inosculate. The arterial arch which is seen above the olecranon fossa is formed by the inosculation of the inferior ulnar collateral artery with interosseous recurrent and radial collateral arteries on the lateral side and joined from above by the middle collateral artery.

THE FRONT OF THE WRIST AND THE PALM OF THE HAND

Surface Anatomy.—On the lateral side of the front of the wrist the tubercle of the navicular bone and the ridge on the volar surface of the greater multangular bone can be felt ; while on the medial side is the prominence caused by the pisiform bone. In the middle of the palm is a triangular, hollow depression with its apex directed upwards towards the wrist. On the ulnar side of the palm is a rounded eminence called the *hypothenar eminence* produced by the short muscles of the little finger and on the radial side is another elevation called the *thenar eminence* formed by the short muscles of the thumb. There are three well marked furrows on the skin of the palm : of these the lowest one is more or less transversely situated and corresponds to the metacarpophalangeal joints.

Dissection. The digits should be well separated and fixed to a wooden board with small nails. Reflect the skin of the palm by the following incisions :—(1) A vertical incision along the middle line of the palm ; (2) a transverse incision along the roots of the fingers ; (3) from the transverse cut vertical incisions along the middle lines of the front of the digits. In reflecting the skin take care not to injure (*a*) the subcutaneous muscle, palmaris brevis, placed across the upper part of the hypothenar eminence ; (*b*) the superficial transverse fasciculi placed across the palm at the roots of the fingers, and (*c*) the three cutaneous nerves descending from the forearm p. 530.

The **Superficial Fascia** of the palm contains granular fat placed between fibrous septa which pass between the skin and the subjacent palmar aponeurosis.

The **Palmaris Brevis** (Fig. 162) consists of transversely disposed fibres situated at the upper part of the hypothenar eminence. It arises from the transverse carpal ligament and from the central portion of the palmar aponeurosis. The fibres are inserted into the skin on the medial border of the palm. Beneath it are seen the ulnar artery and the ulnar nerve. The development of the muscle va.ies ; sometimes it is represented by a few scattered fibres. It is supplied by the ulnar nerve. It wrinkles the skin of the medial side of the palm.

The *superficial transverse fasciculi* consist of a thin band stretching across the roots of the fingers. It is intimately

attached to the skin at the clefts of the fingers. Beneath it are seen the digital arteries and nerves.

Cutaneous Nerves of the Palm.—The *palmar cutaneous branch of the ulnar nerve* has been secured where it pierces the deep fascia above the wrist. It supplies the skin on the medial aspect of the palm.

The *palmar cutaneous branch of the median nerve* pierces the deep fascia above the transverse carpal ligament. It descends over the ligament and divides into two branches, a lateral and a medial. The lateral branch supplies the skin over the thenar eminence and communicates with the terminal part of the lateral antibrachial cutaneous nerve. The medial branch supplies the skin of the palm and communicates with the palmar cutaneous branch of the ulnar nerve.

The *terminal part of the lateral antibrachial cutaneous nerve* descends from the forearm to supply the skin of the ball of the thumb. It communicates with the palmar cutaneous branch of the median nerve and with the superficial branch of the radial nerve.

Superficial Veins of the Palm.—The *proper volar digital veins* pass along the volar aspects of the digits in the superficial fascia. They open proximally into the superficial venous plexus overlying the thenar and hypothenar eminences on the palmar aponeurosis. Opposite the clefts between the fingers the proper volar digital veins communicate with the dorsal veins by means of oblique intercapitular veins. The superficial venous plexus in the palm drains into the median antibrachial vein which has been traced in the forearm.

Dissection. Remove the superficial fascia with the cutaneous nerves and superficial veins and clean the dense palmar aponeurosis underneath. While cleaning it note that its central portion is thick and the lateral and medial portions covering the thenar and hypothenar eminences respectively are thinner. Trace the central portion distally and note that it splits into four overlying slips for the four fingers. In the gaps between the diverging digital slips clean the digital nerves and vessels as they pass to the digits without injuring the transverse fibres stretchiing between the angles of separation of the slips. The lumbrical muscles which appear in these gaps are also to be cleaned. Trace one of the digital slips and see how it again splits into two diverging strips embracing the flexor aspect of each digit. Divide the palmaris brevis at its origin from the palmar aponeurosis and

reflect it medially leaving it attached at its insertion into the skin. While reflecting it note the comparatively thick branch of the superficial division of the ulnar nerve entering its deep surface to supply it.

The **Palmar Aponeurosis** (palmar fascia) is a silvery white membrane consisting of three portions, lateral, central, and medial. The *lateral* and *medial portions* are thin and cover the muscles of the thumb and little finger respectively. The *central portion* is very strong and dense, and occupies the middle of the palm. It has a triangular outline, the apex being directed towards the wrist where it is attached to the transverse carpal ligament and where the expanded tendon of the palmaris longus is blended with it. The base is broad and directed distally. Near the

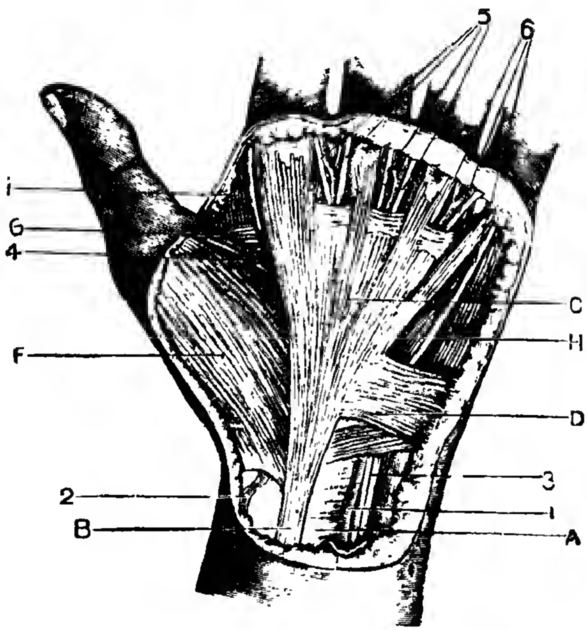

Fig. 162.—Superficial dissection of the palm (Cunningham).

A. Transverse carpal ligament.
B. Tendon of palmaris longus.
C. Palmar aponeurosis.
D. Palmaris brevis.
F. Abductor pollicis brevis.
G. Adductor pollicis (transverse portion).
H. Adductor digiti quinti.
I. First dorsal interosseous muscle.

1. Ulnar artery.
2. Superficial volar artery
3. Ulnar nerve.
4. Proper volar digital branch of median nerve.
5. Proper volar digital branches of median nerve.
6. Proper volar digital branches of ulnar nerve.

metacarpophalangeal articulations it divides into four slips for the four fingers. Transverse fibres stretch between these slips at their angles of separation. The digital vessels and nerves and the lumbrical muscles are seen in the intervals between these digital slips. Examine any one of these four digital slips. Each slip will be seen to lie in front of the sheath of the flexor tendons proceeding to the finger and to split into two diverging strips, forming an arch beneath which the flexor tendons proceed distally to their insertion. The arch is attached to the subjacent sheath of the flexor tendons and higher up to the transverse metacarpal ligament connecting the heads of the metacarpal bones.

Dissection. Cut through the central part of the palmar aponeurosis near its attachment to the transverse carpal ligament and throw it towards the fingers. Note that from the deep surface of the medial and lateral margins of the central portion of the aponeurosis two septa pass backwards and join a layer of fascia covering the volar surfaces of the interosseous muscles. These two septa divide the palm into three fascial compartments. The lateral compartment contains the muscles of the thenar eminence ; the medial, the muscles of the hypothenar eminence and the superficial branch of the ulnar nerve. The central compartment contains the long flexor tendons, the lumbricales, the termination of the median nerve and the superficial volar arch. Clean the superficial volar arch and find its branches to the digits. Remove the lateral portion of the palmar aponeurosis and define the muscles of the thenar eminence. Separate the abductor pollicis brevis which lies laterally from the superficial head of the flexor pollicis brevis which lies medially. The opponens pollicis lies under cover of both. Similarly remove the medial portion of the palmar aponeurosis and define the muscles of the hypothenar eminence. Separate the abductor digiti quinti which lies medially from the flexor digiti quinti brevis which lies laterally. The opponens digiti quinti lies under cover of both. Trace the median nerve and secure its muscular and digital branches. Trace the ulnar nerve and note its division into the superficial and deep branches. Clean the digital branches given off from the superficial division. Note that the deep division dips between the abductor digiti quinti medially and the flexor digiti quinti brevis laterally, and supplies them with muscular branches. While cleaning the third and fourth digital branches of the median nerve take

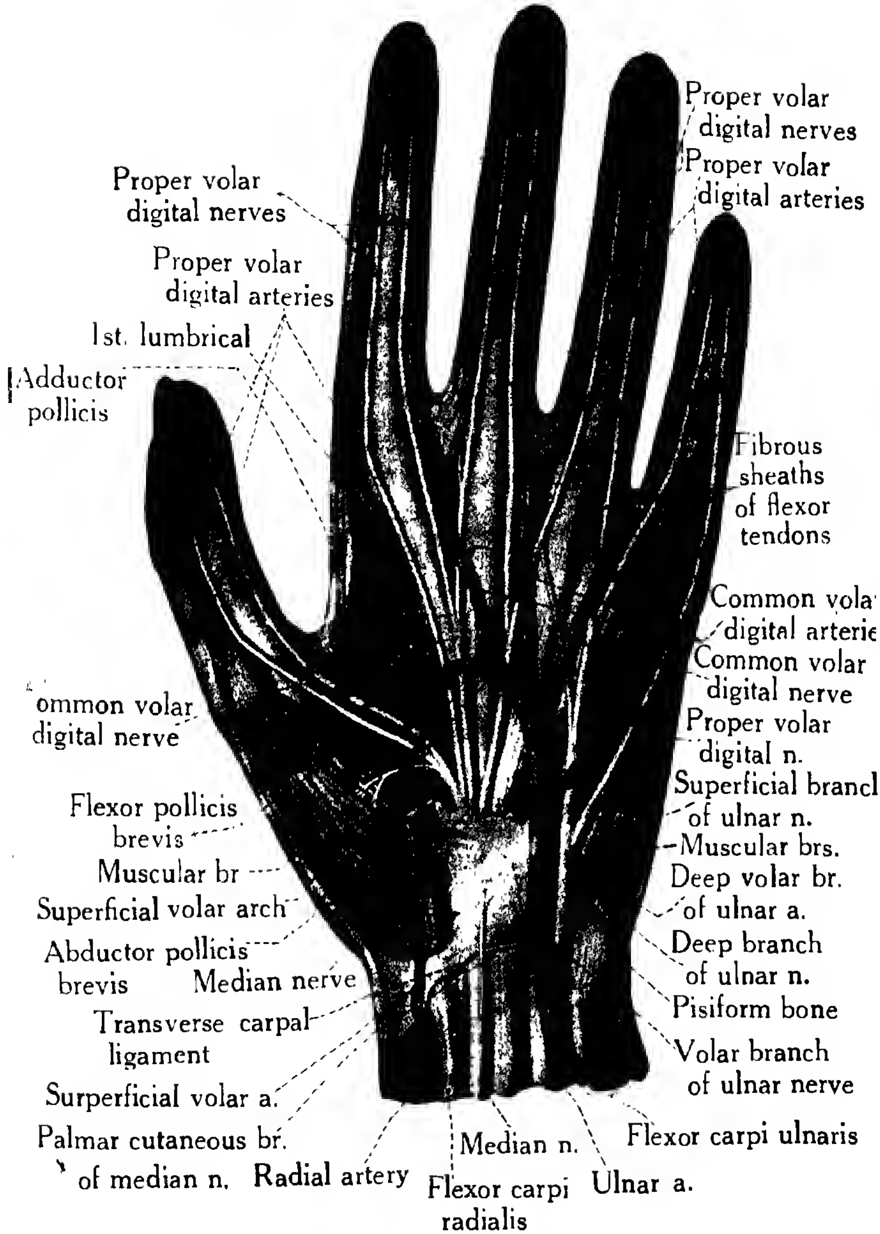

Fig. 163.—Deep dissection of the palm (Sobotta).

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care of one slender twig given off from each of them to the first and second lumbrical muscles.

Superficial Volar Arch (Superficial palmar arch).—The ulnar artery enters the palm by crossing the medial end of the transverse carpal ligament. It continues downwards for a short distance, arches lateralwards across the palm and completes the superficial volar arch by anastomosing with the superficial volar artery or with the arteria volaris radialis indicis or with the arteria princeps pollicis. The convexity of the arch is directed downwards towards the fingers. The superficial volar arch is in relation anteriorly with the palmaris brevis and the central portion of the palmar aponeurosis, while posteriorly with the transverse carpal ligament, the flexor digiti quinti brevis, the opponens digiti quinti, the superficial flexor tendons, and the digital branches of the median nerve.

The **Branches of the Ulnar Artery** at this stage, are the deep volar branch, the proper digital branch, and three common digital branches.

The *deep volar branch* passes backwards between the abductor digiti quinti and the flexor digiti quinti brevis througn the fibres of the opponens digiti quinti and completes the deep volar arch by joining the terminal part of the radial artery. The proper *volar digital branch* arises from the ulnar end of the superficial volar arch. It supplies the medial side of the little finger. The *common volar digital branches* are three in number. They arise from the convexity of the superficial volar arch. They lie in the intervals between the flexor tendons over the digital nerves and are joined by the corresponding volar metacarpal branches of the deep volar arch. Each of these bifurcates opposite the interspace between two contiguous fingers into proper digital branches. These proper digital branches pass along the contiguous sides of the fingers beneath the digital nerves. The two proper digital arteries which run along the sides of a finger anastomose with each other forming an arch near the termination of the last phalanx. From this arch minute twigs are supplied to the subcutaneous tissue of the finger tip and the nail bed. They also communicate by dorsal branches with the dorsal digital arteries.

Ulnar Nerve.—The ulnar nerve enters the palm by crossing the transverse carpal ligament close to the pisiform bone. Here

it lies on the medial side of and a little behind the ulnar artery. Immediately below the pisiform bone, it divides into a superficial and a deep branch. The *superficial branch* supplies the palmaris brevis and the skin on the medial side of the palm and ends in two branches, a proper volar digital nerve and a common volar digital nerve. The former supplies the medial side of the little finger; the latter sends a communicating filament to the median nerve and then divides into two proper volar digital nerves which supply the contiguous sides of the little and ring fingers. At the terminal phalanx the digital nerve divides into two branches, of which one supplies the pulp and the other ramifies beneath the nail. The *deep branch* accompanies the deep branch of the ulnar artery, and will be traced at a later stage of the dissection.

The **Median Nerve** enters the palm by passing beneath the transverse carpal ligament. Here it becomes enlarged and flattened and divides into two portions, a lateral and a medial. The *lateral portion* gives off (1) a *muscular branch* which supplies the abductor pollicis brevis, opponens pollicis, and the superficial head of the flexor pollicis brevis; and (2) three *proper volar digital branches*, two of which are distributed to the sides of the thumb and the third to the radial side of the index finger after supplying a twig to the first lumbrical muscle. The *medial portion* gives off (1) two *common volar digital branches*, of which the lateral one supplies a twig to the second lumbrical muscle and divides at the cleft between the fingers into two proper volar digital branches which supply the contiguous sides of the index and middle fingers. The medial one sometimes supplies a twig to the third lumbrical muscle and divides opposite the cleft between the middle and ring fingers to supply the contiguous sides of those fingers. The proper volar digital nerves are distributed to the fingers in the same manner as those of the ulnar nerve. Each of these proper volar digital nerves also gives off one or two dorsal twigs to supply the skin on the dorsal aspects of the terminal phalanges of the corresponding digits.

The student will find that the median nerve supplies (1) the skin, of three and a half digits, viz., the thumb, the index, the middle and the radial half of the ring; and (2) five muscles of the hand), viz., the opponens pollicis, the abductor pollicis brevis, the superficial head of the flexor pollicis brevis and the two lateral lumbricales. The ulnar nerve supplies the remaining digits and the remaining muscles of the hand.

The **Transverse Carpal Ligament** (anterior annular ligament) is an exceedingly strong fibrous band which bridges over the concavity in front of the carpus forming a tunnel for the passage of the flexor tendons from the forearm into the palm. Laterally it is attached to the tubercle of the navicular bone and the ridge on the volar surface of the greater multangular bone. Medially it is attached to the pisiform bone and to the tip of the hook of the hamate bone. Above it is continuous with the antibrachial fascia, and below it is attached to the palmar aponeurosis. At the sides it gives origin to most of the muscles of the thenar and hypothenar eminences. The tendon of the palmaris longus passes along its volar surface to be blended with the palmar aponeurosis. The ulnar artery and nerve and the palmar cutaneous branches of the ulnar and median nerves enter the palm by crossing it superficially. The tendon of the flexor carpi radialis pierces it at its lateral attachment and passes through the groove on the volar surface of the greater multangular bone, within a special compartment and lined with a special mucous sheath. The tunnel which it forms with the front of the carpus is elliptical in shape, with the broad diameter transverse, and gives passage to the tendons of the flexor digitorum sublimis, flexor digitorum profundus, and flexor pollicis longus and the median nerve. The *volar carpal ligament* is another band of fascia lying superficial to the transverse carpal ligament and having the same attachments as those of the latter. It binds the ulnar vessels and nerve to the transverse carpal ligament.

Directions. Now study the short muscles of the thumb and those of the little finger. These have been already defined to a considerable extent.

Short Muscles of the Thumb.—(1) The *abductor pollicis brevis* (abductor pollicis) arises from the transverse carpal ligament, the tubercle of the navicular bone, and the ridge of the greater multangular bone. It is inserted into the radial side of the base of the first phalanx of the thumb. It is supplied by the median nerve. It bends the thumb forwards and also abducts the thumb away from the index finger.

(2) The *opponens pollicis* lies under cover the preceding muscle which should be divided in the middle and reflected in order to expose the muscle fully. It arises from the transverse carpal ligament and from the ridge on the volar surface of the greater multangular bone. It is inserted into the whole of the radial side of the metacarpal bone of the thumb. It gets its

nerve-supply from the median nerve. It draws the metacarpal bone of the thumb medialwards over the palm.

(3) The *flexor pollicis brevis* consists of two portions, a superficial and a deep. The *superficial portion* arises from the transverse carpal ligament and from the ridge on the greater multangular bone. It is inserted into the radial side of the base of the first phalanx of the thumb; a sesamoid bone is seen in its tendon of insertion. The *deep portion* arises from the ulnar side of the base of the first metacarpal bone and is inserted into the medial side of the base of the first phalanx of the thumb; it corresponds to the first volar interosseous muscle. The superficial portion is supplied by the median nerve and the deep portion by the deep branch of the ulnar nerve. It is a flexor and also an adductor of the proximal phalanx of the thumb.

(4) The *adductor pollicis* will be fully exposed if the flexor pollicis brevis is divided in the middle and the divided ends are reflected. It consists of two portions, an oblique and a transverse. The *oblique portion* arises from the volar aspects of the lesser multangular and capitate bones and also from the volar aspects of the bases of the second and third metacarpal bones. The *transverse portion*, triangular in shape, arises from the distal two-thirds of the volar aspect of the third metacarpal bone. The two portions unite and are inserted together at the medial side of the base of the first phalanx of the thumb blending with the insertion of the deep portion of the flexor pollicis brevis. A fasciculus is often given off from the oblique portion which passes under cover of the tendon of the flexor pollicis longus and is blended and inserted with the superficial portion of the flexor pollicis brevis. Both the portions are supplied by the deep branch of the ulnar nerve. It draws the thumb over the palm.

Short Muscles of the Little Finger.—(1) The *abductor digiti quinti* (abductor minimi digiti) arises from the pisiform bone and from the tendon of the flexor carpi ulnaris. It is inserted into the medial side of the base of the first phalanx of the little finger. It is supplied by the deep branch of the ulnar nerve. It abducts the little from the ring finger.

(2) The *flexor digiti quinti brevis* (flexor brevis minimi digiti) arises from the hook of the hamate bone and from the adjacent part of the transverse carpal ligament. It is inserted into the medial side of the base of the first phalanx of the little finger blending with the insertion of the abductor digiti quinti. It is

supplied by the deep branch of the ulnar nerve. It is a flexor and an abductor of the proximal phalanx of the little finger.

The *opponens digiti quinti* (opponens minimi digiti) lies concealed under the two preceding muscles and is exposed by dividing them in the middle and reflecting the divided ends. It arises from the hook of the hamate bone and from the adjacent part of the transverse carpal ligament. It is inserted into the whole length of the medial border of the metacarpal bone of the little finger. It is supplied by the deep branch of the ulnar nerve. It moves the fifth metacarpal bone forwards so as to deepen the hollow of the palm.

Mucous Sheaths of the flexor tendons on the front of the wrist and on the palm. —The formation of the mucous sheaths surrounding the flexor tendons should be understood. They are formed by two tubular closed sacs, an outer and an inner. The walls of the two sacs are continuous at their commencement and termination. The wall of the outer sac lines the tunnel or canal through which the tendon passes while the wall of the inner sac covers the surface of the tendon investing it like the epimysium covering a muscle. There is very little space between the wall of the sac lining the tunnel and the layer investing the tendon and it contains a lubricating fluid just enough to facilitate free movement of the tendons enclosed; it is only in inflamed conditions that a cavity containing fluid is found. Two mucous sheaths envelope all the flexor tendons as they pass through the tunnel beneath the transverse carpal ligament to the palm; of these one surrounds the tendons of the flexores digitorum sublimis and profundus and the other surrounds the tendon of the

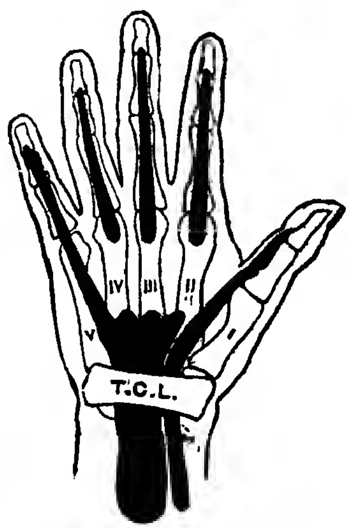


Fig. 164—Diagram to illustrate the arrangement of the mucous sheaths around the flexor tendons of the hand and wrist (Cunningham). T. C. L. Transverse carpal ligament.

flexor pollicis longus. They are prolonged upwards into the forearm for nearly an inch above the transverse carpal ligament. The mucous sheath investing the tendon of the flexor pollicis longus follows the tendon as far as its insertion into the last phalanx of the thumb. The other mucous sheath enveloping the tendons of the flexores digitorum terminates near the middle of the metacarpal bones in blind diverticula. But the offshoot for the tendons of the little finger extends as far as its last phalanx. The mucous sheaths enveloping the digital portions of the flexor tendons of the index, middle and ring fingers extend upwards as far as the junction of the head and body of the corresponding metacarpal bones and hence do not communicate with the large mucous sheath beneath the transverse carpal ligaments.

Dissection. A satisfactory demonstration of the mucous sheaths of the flexor tendons can be made by adopting the following procedure :—Procure a fresh part. Pinch with forceps the anterior wall of the mucous sheath surrounding the tendons of the flexores digitorum sublimis and profundus at its upper most level, i.e., about an inch above the transverse carpal ligament. After filling the syringe with coloured fluid introduce its needle into the sheath held with the forceps and inject into the sheath slowly. It will be seen that the portion of the sheath above the transverse carpal ligament will be distended, then the portion in the middle of the palm and lastly the portion contained in the little finger. The sheath of the tendon of the flexor pollicis longus may be similarly distended and its extent, from an inch above the transverse carpal ligament to the terminal phalanx of the thumb, ascertained. Sometimes these two mucous sheaths communicate with each other behind the transverse carpal ligament.

Fibrous Sheaths of the flexor tendons of the digits.—Cut vertically through the transverse carpal ligament. Observe that two tendons, one from the flexor digitorum sublimis and the other from the flexor digitorum profundus, proceed downwards to each of the four fingers and run along the volar surfaces of their phalanges, while the tendon of the flexor pollicis longus runs lateralwards and downwards along the volar surfaces of the phalanges of the thumb. From the deep flexor tendons the lumbricales arise. In the digits the flexor tendons are contained in osseofibrous canals extending from the metacarpophalangeal articulations to the bases of the last phalanges.

The front wall of the canal is formed by a strong fibrous membrane which arches over the tendons and is attached on either side to the lateral margins of the phalanges and the volar accessory ligaments of the interphalangeal joints ; while the hind wall is osseous being formed by the volar surfaces of the phalanges. Opposite the middle of the first and second phalanges the fibrous sheaths are strengthened by bands of transverse fibres called the *digital vaginal ligaments*. But opposite the joints the sheaths are thin and are formed by circular and cruciate fibres, called the *annular* and *cruciate ligaments* respectively. Slit open one of the fibrous sheaths along the entire length of the digit and note that the mucous sheath lining the fibrous wall of the osseofibrous canal is reflected over the enclosed tendons. Observe that the mucous sheaths of the flexor tendons of the index, middle and ring fingers are blind proximally, extending to the heads of the corresponding metacarpal bones ; whereas that of the thumb is continuous with the mucous sheath covering the tendon of the flexor pollicis longus in the palm. The mucous sheath of the flexor tendons of the little finger is also continuous with the mucous sheath of the same flexor tendons in the palm. Raise the flexor tendons from the subjacent bones and observe that they are connected

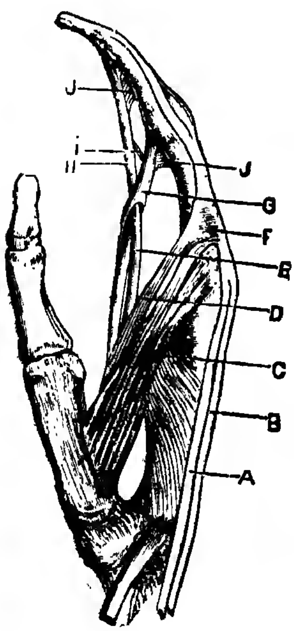


Fig. 165.—Diagram to illustrate the tendons attached to the index finger (Cunningham).

A. Tendon of extensor digitorum communis.

B. Tendon of extensor indicis proprius.

C. First dorsal interosseous muscle.

D. First lumbrical muscle.

E. Flexor digitorum profundus.

F. Expansion of extensor tendon.

G. Flexor digitorum sublimis.

H. Flexor digitorm profundus.

I. J. Vincula tendinea.

to the volar aspects of the phalanges by folds of the mucous sheath, called the *vincula tendinea*, which are of two kinds, short and long. The *vincula brevia* are two in number in each finger ; one fixes the tendon of the flexor digitorum sublimis and the other, the tendon of the flexor digitorum profundus. Each is a triangular fold which extends from the flexor tendon just before its insertion to the subjacent interphalangeal articulation and head of the phalanx. The *vincula longa* are slender thread-like bands which pass from the flexor tendons more proximally. Those from the flexor digitorum sublimis are attached to the proximal part of the palmar surface of the first phalanx. Those from the flexor digitorum profundus are attached either to the divided slips of the flexor digitorum sublimis or to the distal end of the first phalanx.

Insertion of the flexor tendons into the digits.—The mode of insertion of the tendons of the flexores digitorum sublimis and profundus is next to be examined. The tendon of the flexor digitorum sublimis becomes flattened in front of the first phalanx and then divides into two slips to allow the passage of the tendon of the flexor digitorum profundus through it. The two slips of the superficial tendon reunite to form a grooved surface for the passage onwards of the deep flexor tendon, but divides again to be inserted into the margins of the second phalanx. The tendon of the flexor digitorum profundus passes through the aperture in the tendon of the flexor digitorum sublimis in front of the first phalanx and is inserted into the base of the terminal phalanx.

The tendon of the flexor pollicis longus, on reaching the proximal phalanx of the thumb, enters an osseo-fibrous canal similar to those of the fingers and is inserted into the base of the terminal phalanx.

The **Lumbricales** are four slender, rounded muscles which arise from the tendons of the flexor digitorum profundus in the palm. The *first* and *second* lumbricales arise from the lateral margins of the tendons for the index and middle fingers respectively. The *third* arises from the adjacent margins of the tendons for the middle and ring fingers and the *fourth* from the adjacent margins of those for the ring and little fingers. Each terminates in a slender tendon which passes dorsally along the lateral aspect of the corresponding metacarpophalangeal articulation to be inserted into the expansion of the extensor tendon on the dorsum of the first phalanx. The two lateral lumbricales are supplied

by the digital branches of the median nerve and the two medial ones by the deep branch of the ulnar nerve. The lumbrical muscles are flexors of the proximal and extensors of the middle and ungual phalanges.

Dissection. Divide the tendons of the flexor pollicis longus, flexores digitorum sublimis and profundus and throw them towards the fingers. Clean the deep volar arch and trace the deep branch of the ulnar nerve which accompanies it. Then find the branches given off from the deep volar arch and the deep branch of the ulnar nerve. Look for the two twigs to the third and fourth lumbrical muscles. Trace also the branches to the interossei muscles.

Radial Artery in the Palm.—The radial artery enters the palm by passing through the proximal part of the first interosseous space. It appears in the palm between the transverse and oblique portions of the adductor pollicis. It then passes medialwards upon the interossei muscles and across the metacarpal bones below their bases. On reaching the base of the fifth metacarpal bone it joins the deep branch of the ulnar artery to complete the **deep volar arch**. The deep arch is situated about 1 cm. proximal to the superficial volar arch. It lies under cover of the flexor tendons, the lumbricales, and the flexor digiti quinti brevis. The deep branch of the ulnar nerve lies along the arch. The *branches* given off from the radial artery in the palm are :—(1) The *arteria princeps pollicis* which is the first branch of the radial artery in the palm. It runs downwards and lateralwards beneath the oblique portion of the adductor pollicis. Reaching the base of the first phalanx of the thumb it divides into two branches which correspond to the proper volar digital branches of the fingers. These two branches proceed one on either side of the thumb and are distributed like the proper volar digital arteries. (2) The *arteria volaris indicis radialis*. It may have a common origin with the preceding artery. It passes downwards between the first dorsal interosseous muscle and the transverse portion of the adductor pollicis and is distributed to the radial side of the volar aspect of the index finger like the proper volar digital arteries. At the lower border of the adductor pollicis it sometimes sends a communicating branch to the superficial volar arch. The *deep volar arch* (deep palmar arch) gives off the following branches :—(*a*) *volar metacarpal arteries*. These are three in number and arise from the convexity of the arch. They lie on the interosseous muscles as they proceed downwards along

the second, third, and fourth interosseous spaces and anastomose with the corresponding common volar digital branches of the superficial volar arch before their bifurcation. (*b*) *Perforating branches.* These are also three in number and pass backwards from the arch through the proximal parts of the second, third, and fourth interosseous spaces to anastomose with the dorsal metacarpal arteries. (*c*) *Recurrent branches* which are minute twigs proceeding proximally from the concavity of the arch in front of the carpus to anastomose with the volar carpal branches of the ulnar and radial arteries and form a network called the *volar carpal network.*

The deep branch of the ulnar nerve supplies branches to the short muscles of the little finger soon after its origin. It accompanies the deep branch of the ulnar artery and passes between the abductor digiti quinti and the flexor digiti quinti brevis through the fibres of opponens digiti quinti. It then proceeds lateralwards beneath the flexor tendons and lies along the course of the deep volar arch. Reaching the lateral side of the palm it divides into terminal filaments which supply the first dorsal interosseous muscle, the adductor pollicis, and the deep portion of the flexor pollicis brevis. During its course across the palm it supplies branches to all the other interossei and the two medial lumbricales.

The transverse metacarpal ligament should now be examined as it requires to be divided to display the interossei fully. The *transverse metacarpal ligament* is a strong band of fibres placed transversely across the volar aspects of the heads of the medial four metacarpal bones. It is attached to the accessory volar ligaments of the metacarpo-phalangeal joints. It prevents too wide a separation of the metacarpal bones from each other.

Dissection. Divide the transverse portion of the adductor **pollicis** at its origin and reflect it towards the insertion. Divide the transverse metacarpal ligament in the spaces between the fingers. Now clean the volar and dorsal interossei.

The **Interossei Muscles** fill up the intervals between the metacarpal bones. They are divided into two groups, a dorsal and a volar.

The **Dorsal Interossei** are four in number and are better seen from the dorsal aspect of the hand. Each muscle arises by two heads from the opposed surfaces of two contiguous metacarpal bones and the fibres end in a slender tendon. The *first dorsal interosseous muscle* (abductor indicis) (Fig. 165) is

inserted into the radial side of the base of the first phalanx of the index finger and into the expansion of the extensor tendon lying on its dorsum. The *second* and *third dorsal interossei* are inserted into the radial and ulnar sides respectively of the base of the first phalanx of the middle finger and into the expansion of the extensor tendon on its dorsum. The *fourth dorsal interosseous* is inserted into the ulnar side of the base of the first phalanx of the ring finger and into the expansion of the extensor tendon on its dorsum.

The **Volar Interossei** (palmar interossei), three in number, are smaller than the dorsal interossei and are seen only from the volar aspect of the hand. Each muscle arises from a single metacarpal bone. Thus, the *first* arises from the ulnar side of the second metacarpal bone and is inserted into the same side of base of the first phalanx of the index finger and into the expansion of the extensor tendon on its dorsum. The *second* and *third* take their origin from the radial sides of the fourth and fifth metacarpal bones respectively. They are inserted into the same sides of the base of the first phalanges of the ring and little fingers respectively and into the expansions of the extensor tendons lying on their dorsal surfaces.

All the interosseous muscles are supplied by the deep branch of the ulnar nerve. The volar interossei act as adductors of the fingers to a longitudinal line drawn through the centre of the middle finger. The dorsal interossei act as abductors from that line. The interossei also flex the first phalanges and extend the second and third phalanges.

The course of the *tendon of the flexor carpi radialis* along the groove on the volar surface of the greater multangular bone and its insertion into the volar aspects of the bases of the second and third metacarpal bones should now be verified. Note that the tendon is surrounded by a separate mucous sheath extending from an inch (2.5 cm.) above the transverse carpal ligament to its insertion.

ARTICULATIONS

Dissection. Remove the remains of the muscles around the elbow joint. Remove the brachialis from the front and the triceps brachii and anconæus from behind. Remove the muscles attached to the epicondyles of the humerus. Lastly, remove the supinator with care.

Cubital Articulation or **Elbow Joint.**—The elbow joint includes three articulations, **viz.**, (1) the humero-ulnar, (2) the humero-radial, and (3) the proximal radio-ulnar. The bony surfaces entering into the formation of the humero-ulnar articulation are the trochlea of the humerus and the semilunar notch of the ulna ; those of the humero-radial articulation are the capitulum of the humerus and the fovea on the head of the radius ; and those of the proximal radio-ulnar articulation are the medial part of the circumference of the head of the radius and the radial notch of the ulna. Of these three, the humero-ulnar and humero-radial articulations will be considered together and their ligaments are :—

(1) *Articular capsule.*—Its anterior part is attached above to the front aspects of the epicondyles of the humerus on either side and to the upper margins of the coronoid and radial fossæ in the middle. Below it is attached to the anterior and medial margins of the coronoid process and to the annular ligament. The posterior part of the capsule is very thin and loose and is attached above to the posterior surface of the humerus, above the olecranon fossa and behind the capitulum. Below it is attached to the anterior margin of the superior surface of the olecranon and to its lateral border. It is also attached to the annular ligament.

(2) The *ulnar collateral ligament* (internal lateral ligament) consists of three portions, an anterior, a posterior, and an intermediate. The *anterior portion* extends from the front of the medial epicondyle of the humerus to the medial margin of the cornoid process. The *posterior portion* is attached above to the lower and back part of the medial epicondyle of the humerus and below to the medial margin of the olecranon. The *intermediate portion* consists of transverse fibres passing from the medial margin of the olecranon to the medial margin of the coronoid process.

(3) The *radial collateral ligament* (external lateral ligament) is attached above to the lower aspect of the lateral epicondyle of the humerus and below to the annular ligament and to the lateral margin of the olecranon.

The *synovial stratum* lines the deep surface of the entire capsule and is prolonged into the proximal radio-ulnar articulation. Pads of fat are seen between the synovial stratum and the articular capsule ; one above the olecranon fossa ; the second above the coronoid fossa ; and the third over the radial fossa.

Movements.—The humero-ulnar articulation is a hinge-joint and allows of the movements of flexion and extension. The humero-radial articulation is an arthrodial joint and would have permitted all sorts of movements but these are effectively checked by the annular ligament—the joint permitting only the movements of flexion and extension. The *muscles* producing the flexion of these two joints are: brachialis, brachioradialis, biceps brachii, and pronator teres; those producing extension are:—triceps brachii and anconæus.

The Proximal Radioulnar Articulation is a pivot-joint; the head of the radius is the pivot and the osseofibrous ring is formed by the radial notch of the ulna and the annular ligament. The *annular ligament* forms four-fifths of the ring; it is a fibrous band which encircles the head of the radius and is attached to the anterior and posterior margins of the radial notch. To its upper border are attached the articular capsule and the radial collateral ligament of the elbow joint. Its lower border is loosely attached to the neck of the radius below; a thick band extends from this border below the radial notch to the medial side of the neck of the radius and is called the *quadrate ligament*. Its deep surface is lined by a continuation of the synovial stratum of the elbow joint. Its superficial surface gives origin to the supinator muscle. *Movements.*—The joint allows the movements of pronation and supination.

The **Distal Radio-ulnar Articulation** is a pivot-joint. The bony parts entering into the formation of the joint are the head of the ulna and the ulnar notch of the radius. The parts are held together by: (1) The *articular capsule* which is loose; it is attached around the head of the ulna and to the volar and dorsal margins of the ulnar notch of the radius. It is also attached to the volar and dorsal margins of the articular disc lying distal to the head of the ulna. A pouch of the capsule lined by synovial stratum is prolonged upwards between the two bones. (2) The *articular disc* (interarticular fibrocartilage) is triangular in shape and is placed distal to the head of the ulna. Its apex is attached to a depression at the root of the styloid process of the ulna and its base is attached to the prominent margin at the lower end of the radius which lies between the ulnar notch of the radius and its carpal articular surface. The central portion of the disc is thinner than the periphery. It is thus interposed between the distal radio-ulnar joint and the radio-carpal joint. The *synovial stratum* of the joint is very loose.

It extends between the head of the ulna and the articular disc and is prolonged upwards for some distance between the radius and ulna as a pouch called the *recessus sacciformis*. The joint permits the movements of pronation and supination.

There are two ligaments, viz., the interosseous membrane and the oblique cord which bind together the bodies of the radius and ulna. To expose them all the muscles, vessels and nerves from the volar and dorsal aspects of the forearm are to be removed.

The *antibrachial interosseous membrane* extends from the interosseous crest of the radius to that of the ulna. Its fibres are mostly directed from the radius downwards and medialwards to the ulna. Above it extends up to a point about one inch below the tuberosity of the radius; the interval between its upper margin and the oblique cord gives passage to the dorsal interosseous vessels. Below it is continuous with the articular capsule of the distal radio-ulnar joint. At about the junction of its upper three-fourths with the lower fourth it is pierced by the volar interosseous vessels. Its volar and dorsal surfaces give origin to some of the muscles of the forearm which have been already referred to. The volar interosseous vessels and nerve run along its volar surface. The *oblique cord* (oblique ligament) is a fibrous band which extends obliquely from the tubercle at the base of the coronoid process downwards and lateralwards to the radius immediately below its tuberosity.

Dissection. Remove the long flexor tendons from the front of the wrist and the digits. The short muscles of the thumb and little finger are also to be removed. Cut away the remains of the volar carpal and transverse carpal ligaments. On the dorsal aspect remove the dorsal carpal ligaments and divide the extensor tendons of the digits opposite the middle of the metacarpus. Remove the insertions of the extensor carpi ulnaris, abductor pollicis longus and the extensor carpi radialis longus and brevis.

The **Radiocarpal Articulation** or **Wrist Joint** is a condyloid articulation; the concave articular surface being formed by the inferior surface of the lower end of the radius and the inferior surface of the articular disc, while the ovoid convex articular surface is formed by the superior surfaces of the navicular, lunate, and triquetral bones. The ligaments belonging to this articulation are :—

(1) The *articular capsule* is attached above to the volar and

dorsal margins of the articular surface of the radius and of the articular disc. Below it is attached to the volar and dorsal aspects of the first three bones of the carpus.

(2) The *volar radiocarpal ligament* is attached above to the anterior margin of the lower end of the radius and its styloid process. It is also attached to the anterior aspect of the head of the ulna. Below it is attached to the volar surfaces of the navicular, lunate, and triquetral bones; some fibres are prolonged to the capitate bone.

(3) The *dorsal radiocarpal ligament* extends from the posterior border of the lower end of the radius to the dorsal surfaces of the navicular, lunate, and triquetral bones.

(4) The *ulnar collateral ligament* (internal lateral ligament) passes from the tip of the styloid process of the ulna to the triquetral and pisiform bones.

(5) The *radial collateral ligament* (external lateral ligament) stretches from the tip of the styloid process of the radius to the lateral side of the navicular bone.

Open the radiocarpal joint and examine the articular surfaces. The *synovial stratum* lines the articular capsule and the articular surfaces. Rarely it is continuous with the synovial stratum of the distal radio-ulnar articulation.

The **Movements** permitted in the wrist joint are flexion, extension, adduction, and abduction. The muscles producing *flexion* are flexor carpi radialis, flexor carpi ulnaris, palmaris longus, flexor pollicis longus, and flexores digitorum sublimis and profundus; those producing *extension* are extensores carpi radiales longus and brevis, extensor carpi ulnaris, extensor digitorum communis, extensor indicis proprius, extensores pollicis longus and brevis, extensor digiti quinti proprius; those producing *adduction* are flexor carpi ulnaris and extensor carpi ulnaris; those producing *abduction* are extensor carpi radialis longus, abductor pollicis longus, extensores pollicis longus and brevis.

Intercarpal Articulations.—These include: (I) articulations between the contiguous bones of the proximal row of the carpus; (II) the midcarpal articulation between the proximal and distal rows of the carpus; and (III) those between the contiguous bones of the distal row of the carpus.

I. *Articulations between the bones of the proximal row.*—The bones of the proximal row are held together by *volar ligaments* which connect the volar surface of the lunate with that of the navicular bones on the lateral side and of the triquetral

bone medially. The *dorsal ligaments* connect the dorsal surfaces of the same three bones in a similar manner. The *interosseous ligaments* are two in number and are interposed between the contiguous bones. One connects the lunate and navicular bones and the other the lunate and triquetral bones. They fill up the gaps between the proximal articular surfaces of these bones. The ligaments connecting the pisiform bone are :—(1) The *articular capsule* which surrounds the articular surface of the pisiform bone and that on the volar surface of the triquetral bone. It is lined by a separate synovial stratum. (2) The *pisohamate ligament* connects the pisiform with the hamate bone. (3) The *pisometacarpal ligament* connects the pisiform bone with the base of the fifth metacarpal bone. *Movements.*—Slight gliding movements are permitted in these arthrodial joints.

II. The *midcarpal articulation* is formed by the first three carpal bones of the proximal row above and all the bones of the distal row below. The ligaments belonging to this articulation are :—(1) The *volar ligament* which connects the volar surfaces of the bones entering into the formation of the joint. A band radiates from the volar surfaces of the head of the capitate bone to the neighbouring bones and is called the *ligamentum carpi radiatum*. (2) The *dorsal ligaments* connect the dorsal surfaces of the bones entering into the formation of the joint. (3) The *radial collateral ligament* (external lateral ligament) connects the navicular and greater multangular bones laterally. (4) The *ulnar collateral ligament* (internal lateral ligament) passes from the triquetral to the hamate bone medially. *Movements.*—

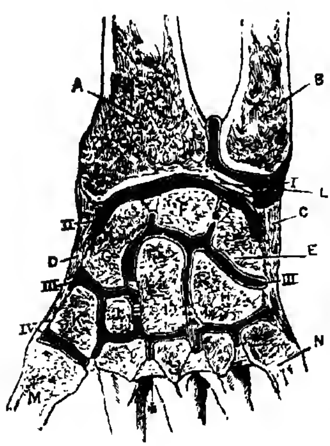


Fig. 166.—Coronal section of the wrist showing the synovial strata.

A. Radius.
B. Ulna.
C. Ulnar collateral ligament.
D. Radial collateral ligament.
E. Triquetral bone.
F. Lunate bone.
G. Navicular bone.
H. Hamate bone.
I. Capitate bone.
J. Lesser multangular bone.
K. Greater multangular bone.
L. Articular disc.
M. Metacarpal bone of thumb.
N. Metacarpal bone of little finger.
I, II, III, IV.—Synovial strata.

Flexion and extension are the only movements permitted in the midcarpal joint.

The midcarpal joint should now be opened and the articular surfaces examined.

III. *Articulations between the bones of the distal row.*— These articulations have three volar, three dorsal and three interosseous ligaments between the four bones of this row. *Movements.*—Slight gliding movements are permitted in these arthrodial joints.

Synovial Strata of the Carpal Joints.—The *synovial stratum* of the midcarpal joint lying between the proximal and distal rows of the carpus extends proximally as two pouches between the contiguous sides of the navicular, lunate, and triquetral bones. Distally the stratum is prolonged between the four bones of the distal row as three pouches. Of these the prolongation between the greater and lesser multangular bones and that between the lesser multangular and hamate bones are usually continuous with the synovial stratum of the carpometacarpal joints. The articulation between the pisiform and triquetral bones has a separate synovial stratum.

Intermetacarpal Articulation.—The metacarpal bones of the four fingers are connected with each other by volar, dorsal and interosseous ligaments at their bases. The *transverse metacarpal ligament* also binds the heads of these bones and has already been examined (p. 542.) The synvoial stratum lining these joints is continuous proximally with that of the carpometacarpal joints. *Movements.*—Slight gliding movements are permitted in these joints.

The **Carpometacarpal Joints** consist of :—

(A) *Carpometacarpal articulation of the thumb.*—The metacarpal bone of the thumb articulates by its base with the greater multangular bone. The articular surfaces are saddle-shaped. The joint is provided with an *articular capsule* lined by a separate synovial stratum. *Movements.*—This is a saddle-shaped articulation and allows flexion, extension, abduction, adduction, circumduction and the movement of opposition.

(B) *Articulations between the carpus and the metacarpal bones of the four fingers.*—The ligaments of these joints are :—(1) One volar ligament along the volar aspect of each of these metacarpal bones. (2) Two dorsal ligaments for each of these metacarpal bones except the fifth. (3) The interosseous ligament which extends from the contiguous inferior angles of the capitate

and hamate bones to the medial side of the base of the third metacarpal bone. The synovial stratum is usually continuous proximally with that of the midcarpal joint by three pouches passing proximally between the four bones of the distal row of the carpus. But the synovial stratum lying between the hamate proximally and the fourth and fifth metacarpal bones distally sometimes remains separate and hence does not communicate with the synovial stratum of the midcarpal joint. *Movements.*—Only slight gliding movements are permitted in these joints.

Metacarpophalangeal Articulations.—These are five condyloid articulations between the head of the metacarpal bone and the base of the phalanx of each digit. The ligaments are:—(1) Accessory volar ligaments (anterior ligaments) which are strong bands placed along the volar aspects of the articulations. They are firmly attached to the bases of the phalanges and loosely to the heads of the metacarpal bones. They are continuous on either side with the collateral ligaments. (2) The collateral ligaments (lateral ligaments) extend along the sides of the joints, from the posterior tubercles and the adjacent depressions on the heads of the metacarpal bones to the sides of the bases of the proximal phalanges. They are continuous in front with the accessory volar ligaments. These joints are protected dorsally by the expansions of extensor tendons. *Movements.*—These are condyloid articulations and allow of flexion, extension, abduction and adduction, the last two movements being with reference to an imaginary line passing through the middle of the middle finger.

Digital Articulations.—These are hinge-joints. Each joint is provided with an accessory volar and two collateral ligaments which are arranged like those of the metacarpo-phalangeal articulations. These joints are protected dorsally by the expansions of extensor tendons. These are hinge-joints and the movements permitted are flexion and extension only.

TABLE OF THE ARTERIES OF THE SUPERIOR EXTREMITY

SUBCLAVIAN .. See Table of Head and neck

is continued in the axilla as

AXILLARY ..
- 1. Highest thoracic .. .. .. From first part
- 2. Thoracoacromial ..
  - 1. Pectoral
  - 2. Acromial
  - 3. Clavicular
  - 4. Deltoid
  - (1–4 and Lateral thoracic: From second part)
- 3. Lateral thoracic .. ..
- 4. Subscapular .. Scapular circumflex ..
- 5. Anterior humeral circumflex .. ..
- 6. Posterior humeral circumflex .. ..
- (4–6: From third part)

is continued in the arm as

BRACHIAL ..
- 1. A. Profunda brachii ..
  - 1. Middle collateral
  - 2. Radial collateral
  - 3. Nutrient
- 2. Nutrient
- 3. Superior ulnar collateral
- 4. Inferior ulnar collateral
- 5. Muscular
- 6. Radial ..
  - 1. Radial recurrent .. ..
  - 2. Muscular .. ..
  - 3. Volar carpal .. ..
  - 4. Superficial volar .. ..
  - (1–4: in forearm)
  - 5. Dorsal carpal . ..
  - 6. First dorsal metacarpal ..
  - (5–6: at wrist)
  - 7. A. princeps pollicis .. .. ..
  - 8. A. volaris indicis radialis . ..
  - . Deep volar arch .. ..
    - 1. Volar metacarpal
    - 2. Perforating
    - 3. Recurrent ..
  - (7–deep volar arch: In hand)
- 7. Ulnar ..
  - 1. Volar ulnar recurrent ..
  - 2. Dorsal ulnar recurrent ..
  - 3. Common interosseous .. ....
    - Volar interosseous
    - Dorsal interosseous
  - 4. Muscular .. ..
  - (1–4: in forearm)
  - 5. Volar carpal .. ..
  - 6. Dorsal carpal .. ..
  - (5–6: at wrist)
  - 7. Deep volar branch .. ..
  - 8. Superficial volar arch — common volar digital
  - (7–8: in hand)

SUPERFICIAL VEINS OF SUPERIOR EXTREMITY

- 1. Basilic vein receives
  - 1. Medial end of Dorsal Venous Arch receives
    - 1. Dorsal metacarpal veins
    - 2. Dorsal digital veins
  - 2. Dorsal digital vein of ulnar side of little finger
  - 3. Median antibrachial vein receives .. Volar venous plexus .. receives
    - Proper volar digital veins
  - 4. Superficial veins from medial and back part of forearm and arm
  - 5. Median cubital vein
- 2. Cephalic vein receives
  - 1. Lateral end of Dorsal Venous Arch
  - 2. Dorsal digital veins of thumb
  - 3. Accessory cephalic vein
  - 4. Superficial veins of lateral and back parts of arm
  - 5. Venæ comitantes of thoracoacromial artery

TABLE OF THE NERVES OF THE SUPERIOR EXTREMITY

- Infraclavicular branches are derived from the three cords of the BRACHIAL PLEXUS
  - From Lateral cord
    - 1. Lateral anterior thoracic 5, 6, 7 C
    - 2. Musculocutaneous 5, 6, 7 C . continued as lateral antibrachial cutaneous
    - 3. Lateral head of Median 6, 7 C .. ..
  - From Medial cord
    - 1. Medial head of Median .. ..
      - Median gives off....
        - 1. Articular to elbow joint
        - 2. Muscular
        - 3. Volar interosseous
        - 4 Palmar cutaneous
        - 5. Lateral
          - Muscular
          - Proper volar digital
        - 6. Medial .. Common volar digital
    - 2. Medial anterior thoracic ..
    - 3. Medial antibrachial cutaneous . .. ..
      - Volar
      - Ulnar
    - 4. Medial brachial cutaneous
    - 5. Ulnar .. ..
      - 1. Articular
      - 2. Muscular
      - 3. Palmar cutaneous
      - 4. Dorsal branch .. Dorsal digital branches
      - 5. Volar
        - Superficial
          - Proper volar digital
          - Common volar digital
        - Deep
    - ..8 C., 1 T
  - From Posterior cord
    - 1. Upper subscapular 5, 6 C
    - 2. Lower subscapular 5, 6 C
    - 3. Thoracodorsal 5, 6, 7 C
    - 4. Axillary 5, 6 C ..
      - Anterior
      - Posterior .. Continued as Lateral brachial cutaneous
    - 5. Radial 6, 7, 8 C., 1T
      - 1. Muscular
      - 2. Posterior brachial cutaneous
      - 3. Dorsal antibrachial cutaneous
      - 4. Superficial
        - Lateral
        - Medial .. Dorsal digital nerves
      - 5. Deep .. Continued as Dorsal interosseous

THE INFERIOR EXTREMITY

THE GLUTEAL REGION

Directions. Devote two days to the dissection of this region. The subject must be placed with its face downwards and blocks are to be put beneath the chest and pelvis.

Surface Anatomy.—Before commencing the dissection of this region the student should recognise the following bony landmarks :—(1) the crest of the ilium, terminating anteriorly in (2) the anterior superior iliac spine, and posteriorly in (3) the posterior superior iliac spine ; (4) the tubercle of the crest about 2 inches (5 cm.) behind the anterior superior iliac spine ; (5) the back of the sacrum and coccyx which can be felt along the middle line ; (6) the promienence caused by the ischial tuberosity ; and (7) the greater trochanter of the femur. Observe the prominence of the nates caused by the glutæus maximus ; and the transverse groove, called the *gluteal sulcus*, which corresponds approximately with the lower border of the glutæus maximus. The *natal cleft* is seen as a deep fissure separating the nates below in the middle line. A line drawn from the anterior superior iliac spine to the most prominent part of the ischial tuberosity is called *Nelaton's line ;* this line passes over the highest part of the greater trochanter and also crosses the centre of the acetabulm and is used in surgery for ascertaining dislocations and other injuries of the hip joint.

Dissection. Reflect the skin laterally by the following *incisions* :—(1) A vertical incision from the tip of the coccyx continued along the lower half of the sacrum in the middle line ; (2) a curved incision from the upper end of the vertical incision along the posterior superior iliac spine and the whole length of the crest of the ilium ; (3) from the tip of the coccyx downwards and lateralwards over the back of the thigh terminating at the junction of the upper and middle thirds (Fig. 71). Look for the cutaneous nerves as they ramify in the superficial fascia. In a fat subject it is rather difficult to dissect out all of them satisfactorily. To find out the lateral cutaneous branch of the last thoracic nerve make a vertical incision through the superficial fascia across the tubercle of the iliac crest. As soon as this nerve is secured look for the lateral cutaneous branch of the iliohypogastric nerve which crosses the iliac crest in the same

direction about 1 cm. behind. Make oblique incisons downwards and lateralwards through the superficial fascia covering the posterior third of the iliac crest and secure in this situation the three branches lying close to each other and issuing from the posterior divisions of the first, second and third lumbar nerves. Then make an incision in the superficial fascia from the posterior superior iliac spine to the tip of the coccyx and while reflecting it lateralwards secure the three cutaneous **branches of the sacral nerves** as they **perforate the glutæus** maximus near its origin from the sacrum. As the superficial fascia is reflected along the inferior border of the glutæus maximus secure the perforating cutaneous branch of the second and third sacral nerves turning round the lower border of the muscle between the tip of the coccyx and the ischial tuberosity. The gluteal branches of the posterior fermoral cutaneous nerve will be seen turning upwards round the lower border of the glutæus maximus between the ischial tuberosity and the greater trochanter of the femur.

The **Superficial Fascia** in the gluteal region is more fatty than in any other part of the body, specially in the female.

The **Cutaneous Nerves** are :—(1) The *lateral cutaneous branch of the last thoracic nerve* (p. 20). It crosses the iliac crest about two inches (5 cm.) behind the anterior superior iliac spine and descends in the gluteal region supplying the skin as low down as the greater trochanter. (2) The *lateral cutaneous branch of the ilio-hypogastric nerve* (p. 20). It crosses the iliac crest behind the preceding and supplies the skin above the greater trochanter. (3) The lateral branches of the posterior divisions of the *first, second* and *third lumbar nerves* (p. 235). These cross the back part of the iliac crest and pass downwards and forwards; some twigs reach as far as the greater trochanter. (4) Three cutaneous twigs from the lateral branches of the posterior divisions of the *upper three sacral nerves.* The lateral branches of the posterior divisions of the upper three sacral **nerves form a looped** arrangement over the dorsum of the sacrum (p. 235). From these loops three twigs are given off which pierce the glutæus maximus near its origin from the sacrotuberous ligament and supply the skin over the back part of the buttock. (5) The *perforating cutaneous branch of the second and third sacral nerves.* **It turns round** the lower border of the glutæus maximus between the coccyx and ischial tuberosity. (6) The *gluteal branches of the posterior femoral cutaneous nerve.* These are three or four twigs which turn round the lower border of the glutæus maximus lateral

to the ischial tuberosity and ascend to supply the skin of the lower part of the gluteal region. (7) A few *twigs from the lateral*

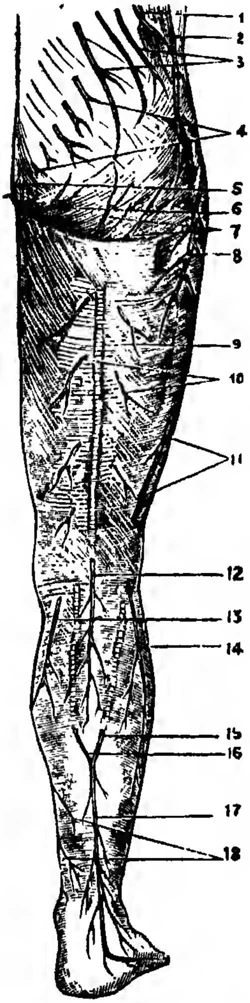


Fig. 167.—Cutaneous nerves of the inferior extremity—posterior view (from Buchanan).

1. Lateral cutaneous branch of ilichy-pogastric nerve.
2. Lateral cutaneous branch of 12th thoracic nerve.
3. Lateral branches of the posterior divisions of 1st, 2nd, and 3rd lumbar nerves.
4. Lateral branches of posterior divisions of 1st, 2nd, and 3rd sacral nerves.
5. Coccygeal nerve.
6. Perforating cutaneous nerve.
7. Gluteal branches of posterior femoral cutaneous nerve.
8. Posterior branch of lateral femoral cutaneous nerve.
9. Porterior femoral cutaneous nerve.
10. Branches to back of thigh from the above nerve.
11. Lateral femoral cutaneous nerve.
12. Posterior femoral cutaneous nerve.
13. Posterior branch of medial femoral cutaneous nerve.
14. Lateral sural cutaneous nerve.
15. Peroneal anastomotic nerve.
16. Medial sural cutaneous nerve.
17. Sural nerve.
18. Branches of the saphenous nerve.

femoral cutaneous nerve. These pass backwards to supply the skin of the front part of the gluteal region. (8) The posterior division of the *coccygeal nerve.* It is distributed to the skin over the back of the coccyx.

Dissection. Remove the remains of the superficial fascia and examine the deep fascia.

The **Deep Fascia** of the gluteal region is a part of the fascia

lata and is attached above to the iliac crest and behind to the dorsum of the sacrum and coccyx. If traced downwards from the iliac crest it is seen to cover the glutæus medius and at the upper border of the glutæus maximus to split into two layers which enclose the latter muscle. At the lower border of the glutæus maximus the two layers reunite and become continuous with the deep fascia of the thigh.

Dissection. Reflect the deep fascia and proceed to clean the glutæus maximus. Adduct and rotate the limb medially so that the fibres of the muscle are made as tense as possible. Remove the fascia over the muscle in one continuous layer. In cleaning the muscle carry the edge of the knife in the direction of its coarse fibres. If the student is dissecting the right inferior extremity it will be more convenient for him to begin at the upper border of the muscle and proceed downwards; but if he is working at the left extremity he should begin at the lower margin of the muscle and work upwards.

The **Glutæus Maximus** is a thick fleshy mass which causes the prominence of the nates. It arises (1) from the posterior gluteal line, and from the narrow rough surface of bone, including the outer lip of the iliac crest lying above and behind it; (2) from the posterior surface of the lower part of the side of the sacrum; (3) from the posterior surface of the upper part of the side of the coccyx; (4) from the aponeurosis of the sacrospinalis; and (5) from the sacrotuberous ligament. The muscle is made up of coarse fasciculi which run parallel to one another and form bundles. The bundles are separated from each other by fibrous septa which penetrate between them. The fasciculi of the muscle pass obliquely downwards, lateralwards and forwards. All the fibres of the upper half of the muscle together with the superficial fibres of the lower half are inserted into the fascia lata of the thigh. The deep fibres of the lower half of th muscle are inserted into the gluteal tuberosity of the femur. The muscle is supplied by the inferior gluteal nerve which enters its deep surface. *Actions.*—It is an extensor of the hip joint. Thus in the act of rising after stooping it extends the trunk on the thigh. Its upper fibres adduct the thigh; its lower fibres assist adduction. By means of its insertion into the fascia lata the iliotibial tract is made tense.

Dissection. Reflect the glutæus maximus by dividing it at its origin from the ilium, sacrum, coccyx and the sacrotuberous ligament. As the muscle is detached from the

sacrotuberous ligament the coccygeal branches of the inferior gluteal artery will be seen entering the deep surface of the muscle after piercing the ligament. The perforating cutaneous branch of the sacral plexus will also be seen piercing the ligament. As the muscle is separated from the underlying structures and thrown downwards and lateralwards the following structures will be revealed: (1) the superficial branches of the superior gluteal vessels which appear at the upper border of the piriformis and enter the deep surface of the glutæus maximus; (2) the branches of the inferior gluteal vessels and the inferior gluteal nerve which appear at the lower border of the piriformis and enter the deep surface of the glutæus maximus. Some of these blood vessels and nerves entering the deep surface of the muscles are to be divided and others pulled out of the muscle so as to facilitate its reflection towards insertion. After reflecting the muscle open up the three following bursæ interposed between it and the greater trochanter of the femur, the tuberosity of the ischium and the tendon of the vastus lateralis.

Mucous bursæ under cover of the glutæus maximus.—Three mucous bursæ are usually found under cover of this muscle; one is situated between it and the greater trochanter of the femur; the second separates it from the tuberosity of the ischium; and the third is placed between the tendon of vastus lateralis and the aponeurotic insertion of the muscle into the gluteal tuberosity of the femur.

Dissection. The muscles exposed on reflecting the glutæus maximus should now be cleaned without injuring the blood vessels and nerves lying under cover of the muscle. Begin with the glutæus medius which lies highest and is placed above the greater sciatic foramen. Next clean the piriformis issuing out of the greater sciatic foramen without injuring the superior gluteal vessels and nerve which issue out of the pelvis between it and the glutæus medius. Hook aside the thick cord like sciatic nerve issuing out of the pelvis below the piriformis together with the inferior gluteal nerve. Clean the obturator internus muscle which emerges from the pelvis through the lesser sciatic foramen and note that its tendon is blended with that of the gemellus superior above and gemellus inferior below, before it is inserted into the greater trochanter of the femur. Below the gemellus inferior is placed the quadrilateral muscle, quadratus femoris, which should be cleaned. Below the lower border of

the quadratus femoris is seen the upper part of the adductor magnus. If the colour injection has flown well, the transverse branch of the medial circumflex artery will be seen lying between the contiguous borders of the two last named muscles. Lastly clean the origin of the muscles attached to the ischial tuberosity, viz., the biceps femoris, semitendinosus and semimembranosus.

Piriformis.—Its origin from the pelvic cavity has been described (p. 118). It comes out of the pelvis through the greater sciatic foramen and passes downwards, lateralwards and forwards to be inserted by a tendon into a rough impression at the upper border of the greater trochanter. Its tendon is blended with that of the obturator internus and gemelli. It is supplied by branches from the first and second sacral nerves. It rotates the thigh outwards.

The **Gemellus Superior** is a small muscle which arises from the outer surface of the spine of the ischium and is blended with the upper border of the tendon of the obturator internus with which it is inserted into the medial surface of the greater trochanter. It is supplied by the nerve which supplies the obturator internus muscle. It rotates the thigh outwards.

Obturator Internus.—Its origin from the pelvic cavity has been described (p. 117). Its tendon issues out of the lesser sciatic foramen, becomes blended with the gemellus superior above and the gemellus inferior below, and is inserted into the medial aspect of the greater trochanter in front of the insertion of the piriformis. The nerve supply and the actions of the muscle have been described on p. 118.

The **Gemellus Inferior** arises from the upper part of the tuberosity of the ischium below the groove for the tendon of the obturator internus. It is blended with the lower border of the tendon of the obturator internus with which it is inserted. It is supplied by a twig from the nerve which goes to supply the quadratus femoris under cover of these muscles. It rotates the thigh outwards.

The **Quadratus Femoris** is a flat quadrilateral muscle which lies below the preceding. It arises from the lateral margin of the tuberosity of the ischium and passes lateralwards to be inserted into the upper part of the linea quadrata of the femur. It is supplied by a special nerve from the sacral plexus which enters its deep surface. It rotates the thigh outwards.

The **Glutæus Medius** is a thick muscle, the posterior third of which is only covered by the glutæus maximus while its

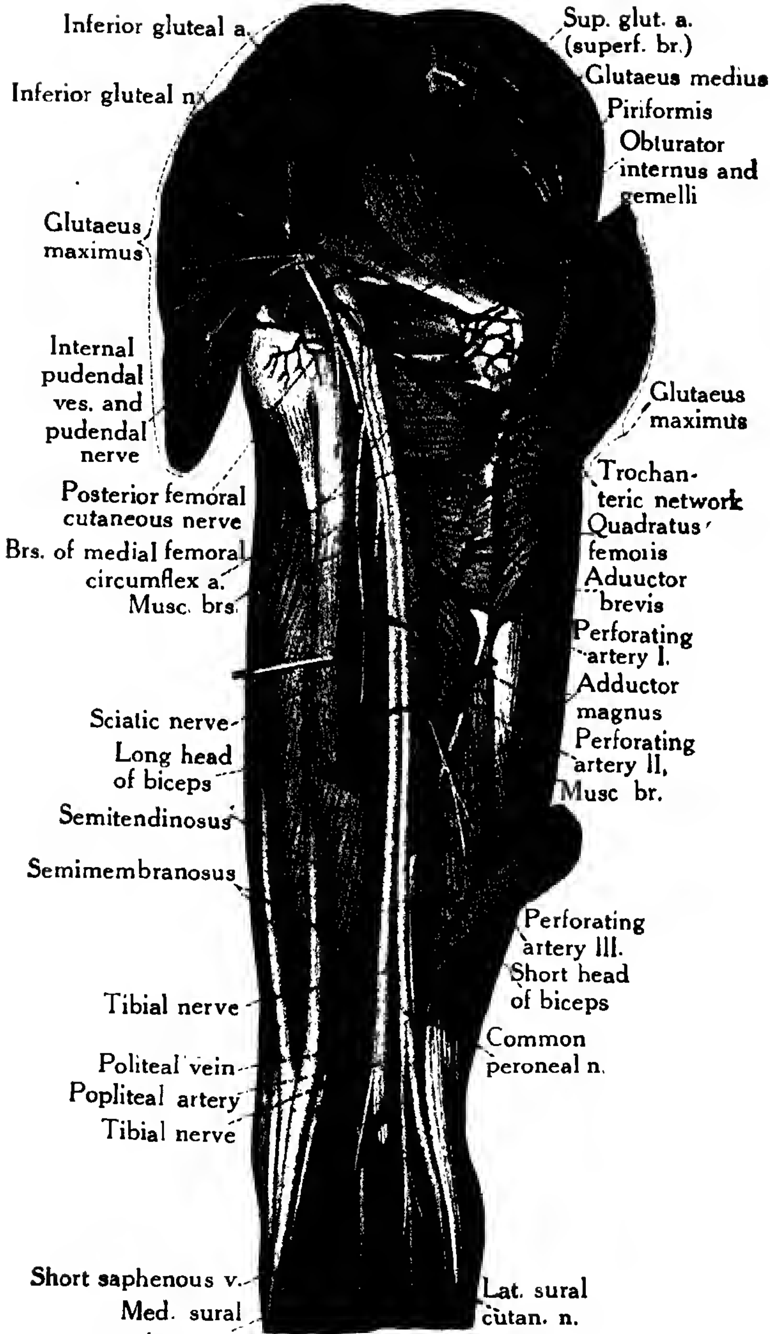


Fig 168.—Dissection of the gluteal region, the back of the thigh and the popliteal fossa (Sobotta)

anterior two-thirds are covered by the deep fascia of the gluteal region. It arises (1) from the outer surface of the ilium between the iliac crest and posterior gluteal line above, and the anterior gluteal line below ; and (2) from the deep fascia covering it. The fibres converge to a tendon which is inserted into the oblique ridge on the lateral surface of the greater trochanter. Its tendon is separated from the greater trochanter above the oblique ridge by a mucous bursa. It is supplied by the superior gluteal nerve. It abducts the thigh ; its anterior fibres rotate the thigh inwards ; its posterior fibres rotate it outwards.

Dissection. The student should now dissect the vessels and nerves which emerge from the pelvis through the greater sciatic foramen and lie below the level of the piriformis. Clean the inferior gluteal artery and its branches. The internal pudendal artery will be seen to lie on the ischial spine. The sciatic nerve passes to the back of the thigh and on its surface lies the arteria comitans nervi ischiadici which is clearly seen in well injected bodies. The posterior femoral cutaneous nerve lies immediately superficial to the sciatic nerve and gives off the long perineal branch which passes medialwards below the ischial tuberosity. On the spine of the ischium is seen the nerve to the obturator internus. Medial to it are the internal pudendal vessels and still more medially is the pudendal nerve. The inferior gluteal nerve lies medial to the posterior femoral cutaneous nerve. The nerve to the quadratus femoris runs downwards along the posterior surface of the superior ramus of the ischium under cover of the obturator internus and gemelli muscles and cannot be traced to its termination till these muscles are divided and reflected.

Inferior Gluteal Artery (sciatic artery).—Its origin from the hypogastric artery has been mentioned (p. 111). Issuing out of the pelvic cavity it passes with the sciatic nerve under cover of the glutæus maximus and is continued to the back of the thigh in company with the posterior femoral cutaneous nerve. It gives off the following branches :—(1) The *muscular branches* supply the glutæus maximus (by entering its deep surface) and the neighbouring muscles. (2) The *coccygeal branches* pass medialwards, perforate the sacrotuberous ligament and supply the glutæus maximus and the skin over the coccyx. (3) The *arteria comitans nervi ischiadici* is a long slender artery. It lies at first on the surface of the sciatic nerve and then pierces it to supply its substance. (4) The *anastomotic branch* descends

to form the upper limb of the *crucial anastomosis* in which the medial and lateral femoral circumflex arteries and the superior

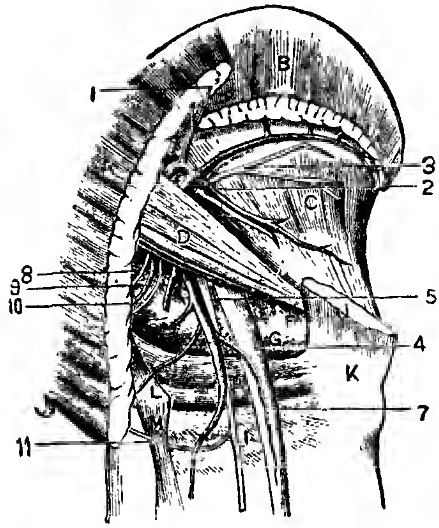


Fig. 169.—Dissection of the gluteal region. The glutæus maximus and glutæus medius have been removed.

A. Glutæus maximus (cut).
B. Glutæus medius (cut).
C. Glutæus minimus.
D. Piriformis.
E. Gemellus superior.
F. Obturator internus.
G. Gemellus inferior.
H. Quadratus femoris.
I. Adductor magnus.
J. Insertion of glutæus medius.
K. Greater trochanter.
L. Ischial tuberosity.
M. Tendon common to biceps femoris and semitendinosus.

1. Superficial part of superior gluteal artery.
2. Lower branch of the deep part of superior gluteal artery.
3. Superior gluteal nerve
4. Sciatic nerve.
5. Posterior femoral cutaneous nerve.
7. Arteria comitans nervi ischiadici.
8. Pudendal nerve.
9. Internal pudendal artery.
10. Nerve to obturator internus.
11. Long perineal branch of posterior femoral cutaneous nerve.

perforating artery take part. (5) The *cutaneous branches* supply the skin of the buttock and upper part of the back of the thigh.

Internal Pudendal Artery.—Its origin inside the pelvic cavity has been described (p. 111). It issues out of the pelvis through the greater sciatic foramen and crosses the outer surface of the ischial spine lying between the pudendal nerve medially and the nerve to the obturator internus laterally. It re-enters the pelvis through the lesser sciatic foramen. It is accompanied by venæ comitantes.

The **Sciatic Nerve** (greater sciatic nerve) is the largest nerve in the whole body. Its origin from the sacral plexus has been described (p. 116). It issues out of the pelvic cavity below the piriformis and descends to the thigh along the interval between the tuberosity of the ischium and the greater trochanter of the femur. In its course it crosses the gemelli, the obturator internus, and the quadratus femoris. It is flattened just after its exit and becomes rounded lower down. The arteria comitans nervi ischiadici at first lies on its surface and then pierces it. The sciatic nerve usually gives off no branch in the gluteal region.

Posterior Femoral Cutaneous Nerve (small sciatic nerve).—Its origin from the sacral plexus has been described (p. 115). It issues out of the pelvis below the piriformis and accompanies the inferior gluteal artery under cover of the glutæus maximus. From the lower border of the glutæus maximus it runs downwards on the back of the thigh being covered by the deep fascia only. Its further course will be subsequently traced. Its branches are all cutaneous. These are :—(1) The *gluteal branches* turn upwards round the lower border of the glutæus maximus and have already been examined. (2) The *perineal branches* supply the skin of the upper and medial aspects of the thigh and of the perineum. One of these branches is longer than the others and is called the *long perineal branch*. It passes medialwards below the tuberosity of the ischium towards the perineum. Its course and distribution in the perineum have been described (p. 7). (3) The *cutaneous branches* for the thigh supply the medial and back parts of the thigh.

Pudendal Nerve.—Its origin from the pudendal plexus has been described (p. 117). It issues out of the pelvis below the piriformis and, crossing the outer surface of the ischial spine medial to the internal pudendal vessels, re-enters the pelvis through the lesser sciatic foramen and becomes distributed in the perineum. (p. 5).

Inferior Gluteal Nerve.—Its origin from the sacral plexus has been described (p. 115). It breaks up into many branches which enter the deep surface of the glutæus maximus to supply it.

Nerve to the Obturator Internus.—Its origin from the sacral plexus has been described. It crosses the ischial spine lateral to the internal pudendal vessels and supplies a twig to the gemellus superior. It re-enters the pelvis through the lesser sciatic

foramen and enters the pelvic surface of the obturator internus to supply it.

Dissection. Divide the obturator internus and gemelli at their middle from above downwards. On raising their medial portions, the nerve to the quadratus femoris is seen to proceed downwards in front of them ; it should be followed to the point where it enters the substance of the muscle. Look for the twig to the gemellus inferior given off from this nerve. Next divide the quadratus femoris at its middle from above downwards and reflect the divided ends on either side. This brings into view the tendon of the obturator externus, the terminal deep branch of the medial femoral circumflex artery and the posterior part of the articular capsule of the hip joint.

Nerve to the Quadratus Femoris.—Its origin from the sacral plexus has been described. Emerging from the greater sciatic foramen it passes downwards and crosses the superior ramus of the ischium under cover of the sciatic nerve, the gemellus superior, the obturator internus and the gemellus inferior. It terminates by entering the deep surface of the quadratus femoris. It gives a twig to the gemellus inferior which enters the deep surface of the muscle. It gives an *articular twig* to the hip joint which enters the back part of the articular capsule.

Obturator Externus.—The tendon of this muscle can be seen by separating the contiguous margins of the gemellus inferior and the quadratus femoris when these muscles are intact. As these muscles have been reflected the insertion of the tendon of the obturator externus into the trochanteric fossa of the femur is clearly seen. The origin of the muscle will be studied later on.

The **Medial Femoral Circumflex Artery** terminates at the upper margin of the adductor magnus by dividing into a superficial and a deep branch. The *superficial branch* passes between the quadratus femoris and the upper border of the adductor magnus, anastomoses with the transverse branch of the lateral femoral circumflex artery and thus contributes to the formation of the crucial anastomosis. The *deep branch* passes obliquely upwards in front of the quadratus along with the tendon of the obturator externus towards the trochanteric fossa and anastomoses with the gluteal arteries.

Now study the structures which lie above the level of the piriformis. These are :—the superior gluteal vessels, the superior gluteal nerve, the glutæus medius (already described) and the glutæus minimus.

Dissection. Divide the glutæus medius above the greater trochanter. Reflect the upper part upwards, carefully separating it from the subjacent glutæus minimus. During this reflection the deep branch of the superior gluteal artery, the superior gluteal nerve and their branches will be seen to lie between the two muscles ; they are to be cleaned and traced. When the tendinous lower part is reflected up to its line of insertion into the oblique line of the greater trochanter, a bursa will be seen to lie between the tendon and the lateral surface of the trochanter above the oblique line over which it glides.

Superior Gluteal Artery.—Its origin from the hypogastric artery has been described (p. 112). It issues out of the pelvis through the greater sciatic foramen above the piriformis and immediately divides into a superficial and a deep branch. The *superficial branch* divides into several branches which enter the deep surface of the glutæus maximus. These have been examined while the glutæus maximus was reflected. The *deep. branch* immediately subdivides into a superior and an inferior division. The superior division proceeds forwards towards the anterior superior iliac spine by crossing the upper limit of the glutæus minimus. It anastomoses with the deep circumflex iliac artery and with the ascending branch of the lateral femoral circumflex artery. The inferior division crosses the surface of the glutæus minimus obliquely to the greater trochanter ; it accompanies the inferior branch of the superior gluteal nerve and supplies the glutæus medius and minimus ; some twigs pierce the latter muscle to supply the hip joint. The venæ comitantes open into the hypogastric vein.

Superior Gluteal Nerve.—Its origin from the sacral plexus has been described (p. 115) It issues out of the pelvis through the greater sciatic foramen above the piriformis and immediately divides into a superior and an inferior branch. The *superior branch* accompanies the superior division of the deep branch of the superior gluteal artery and supplies the glutæus minimus. The *inferior branch* accompanies the inferior division of the deep branch of the superior gluteal artery and supplies the glutæus medius and minimus and ends in the tensor fasciæ latæ.

The **Glutæus Minimus** lies beneath the glutæus medius and arises from the outer surface of the ilium between the anterior and inferior gluteal lines and from the margin of the greater sciatic notch. Its muscular fibres ultimately end in a tendon which is inserted into an impression on the anterior border of the

greater trochanter of the femur. This tendon of insertion is intimately connected with the articular capsule of the hip joint and is separated from the upper and the anterior part of the greater trochanter by a bursa. The glutæus minimus is supplied by the superior gluteal nerve. It abducts the thigh ; its anterior fibres rotate the thigh inwards.

"Parts" covered by the Glutæus Maximus.—Most of the structures covered by the glutæus maximus have been examined and the student is now in a position to enumerate them. These are : (I) *Muscles.*—1. Glutæus medius. 2. Piriformis. 3, 4, 5. Obturator internus and two gemelli. 6. Quadratus femoris. 7. Tendon of obturator externus. 8. Upper part of adductor magnus. 9, 10, 11. Origin of three hamstring muscles from ischial tuberosity. (II) *Vessels.*—1, 2. Superior and inferior gluteal vessels. 3. Internal pudendal vessels. 4. Crucial anastomosis. (III) *Nerves.*—1, 2. Superior and inferior gluteal nerves. 3. Sciatic nerve. 4. Posterior femoral cutaneous nerve. 5. Pudendal nerve. 6. Nerve to obturator internus. 7. Nerve to quadratus femoris. (IV) *Bones.*—1. Ilium. 2. Sacrum and coccyx. 3. Tuberosity of ischium. 4. Greater trochanter of the femur. (V) *Ligament.*—Sacrotuberous ligament. (VI) *Bursæ.*—Three mucous bursæ.

"Parts" covered by the Glutæus Minimus.—Reflect the glutæus minimus by cutting close to its origin and throw it downwards ; note that its tendon of insertion is firmly adherent to the capsule of the hip joint. The structures now revealed are :—(1) the reflected tendon of the rectus femoris, which is attached to the dorsum ilii above the margin of the acetabulum; (2) a mucous bursa which is interposed between the tendon of the glutæus minimus and the upper and anterior part of the greater trochanter; (3) portion of the capsule of the hip joint.

THE POPLITEAL FOSSA

Directions. The dissection of the popliteal fossa (popliteal space) should be finished in one day. Put a block under the knee during the dissection of this space.

Surface Anatomy.—Note the prominences of the medial and lateral condyles of the femur. Feel the adductor tubercle at the junction of the medial condyle with its epicondylar ridge. The medial and lateral condyles of the tibia and the head of the fibula can be palpated. On the lateral side the tendon of the

biceps femoris and on the medial side the tendons of the semitendinosus and semimembranosus can be felt above the knee. Below the knee the prominence caused by the two heads of the gastrocnemius is to be noted.

Dissection.—To reflect the skin three *incisions* are required (Fig. 71) :—(1) A vertical incision about ten inches in length along the middle line of the back of the limb, half of it lying above and half below the bend of the knee ; (2) two transverse incisions passing from the medial to the lateral side of the limb, one at the upper and the other at the lower end of the vertical incision. Raise the skin in two flaps and reflect them to their respective sides.

The *superficial fascia* of the popliteal region contains a small quantity of fat. In it the following structures are seen :—(1) The *posterior femoral cutaneous nerve.* Its terminal portion pierces the deep fascia of the popliteal region a little below its middle. The small saphenous vein usually pierces the deep fascia at the same place. Then it descends along the middle line of the leg by the side of the small saphenous vein and terminates about midway between the knee and ankle. Some filaments given off from the nerve pierce the deep fascia in the upper part of the popliteal fossa to supply the skin of that part. (2) The *posterior branch of the medial femoral cutaneous nerve.* It is seen to descend along the medial boundary of the fossa. (3) The *small saphenous vein.* It ascends along the middle line of the back of the leg and pierces the deep fascia at the lower part of the popliteal fossa. Its termination in the popliteal vein will be seen during the deep dissection of the fossa.

Remove the remains of the superficial fascia, preserving the cutaneous structures. The *deep fascia* of the popliteal fossa (popliteal fascia) is thin but very strong ; the strength is due to transverse fibres being intermingled with the longitudinal ones. It receives expansions from the tendons bounding the upper part of the fossa and is continuous above with the deep fascia of the thigh and below with the deep fascia of the leg.

Dissection. Reflect the deep fascia in the same manner and by the same incisions as those for the skin. Do not injure the small saphenous vein and the terminal part of the posterior femoral cutaneous nerve which pierce the fascia. A large quantity of fat is now to be taken out of the fossa without injuring the several small vessels and nerves lying in it. First clean the muscles which form its medial and lateral boundaries supe-

riorly. Thus the semitendinosus and semimembranosus are to be cleaned to their insertions superomedially. The tendon of the biceps femoris should be traced to its insertion superolaterally. Then clean the muscles which form its medial and lateral boundaries inferiorly. The medial head of the gastrocnemius forms the inferomedial boundary and the lateral head of the same muscle together with the plantaris lying underneath forms the inferolateral boundary of the fossa. Incise the union of the two heads of the gastrocnemius vertically; this will facilitate the lower part of the floor of the foosa being exposed fully. The portion of the posterior femoral cutaneous nerve lying under cover of the deep fascia is to be traced proximally. The large tibial nerve will be seen in the middle line of the space. Clean this nerve and secure its branches. Its cutaneous branch, the medial sural cutaneous nerve, descends between the two heads of the gastrocnemius to the superficial surface of the muscle. Of its three articular branches, one accompanies the superior medial genicular branch, the second, the inferior medial genicular branch, and the third, the middle genicular branch of the popliteal artery; they go to supply the knee joint. Note that its five muscular branches, to the soleus, the plantaris, popliteus and one to each head of the gastrocnemius issue, from it as it lies between the two heads of the gastrocnemius—each of them should be traced to its destination. Of these the nerve to the popliteus lies deep in the fossa and crosses the superficial surface of the popliteus to gain its lower border where it enters to supply the muscle. The nerve to the soleus passes under cover of the lateral head of the gastrocnemius. Next clean the common peroneal nerve which lies between the tibial nerve and the medial border of the biceps femoris and trace it to the neck of the fibula across the lateral head of the gastrocnemius below the tendon of the biceps femoris. Secure the branches given off from it in the fossa. Two of its articular branches run in company with the superior and inferior lateral genicular branches of the popliteal artery. Of its two cutaneous branches, the lateral sural cutaneous nerve is limited to the proximal part of the leg while the peroneal anastomotic nerve runs across the lateral head of the gastrocnemius to the middle of the leg to join the medial sural cutaneous branch of the tibial nerve. Sometimes the two cutaneous b ranches of the common peroneal nerve have a common origin. Next search for the slender genicular branch of the obturator nerve ; it will

be seen to lie along the posterior aspect of the popliteal artery in the upper part of the fossa and should be traced to the point where it perforates the oblique popliteal ligament. The popliteal lymph glands should then be looked for and they are to be removed for dissecting out the popliteal artery and its branches. Of the lymph glands one lies near the termination of the small saphenous vein. The rest are placed along the sides of the popliteal artery and vein. While cleaning the popliteal vessels note that the vein lies superficial to the artery and is placed at first lateral to it. Then it crosses the artery superficially and lies to its medial side. Clean the branches of the popliteal artery. Note its muscular branches supplying all the muscles bounding the fossa. Remove some of the muscular branches if necessary to clean the floor of the fossa. Trace the superior medial genicular artery as it crosses the fossa medially above the medial condyle of the femur. The superior lateral genicular artery passes transversely lateralwards above the lateral condyle of the femur. The inferior medial genicular artery passes obliquely downwards and medialwards below the medial condyle of the tibia. The inferior lateral genicular artery passes lateralwards above the head of the fibula. The middle genicular artery pierces the oblique popliteal ligament in the centre in company with the corresponding genicular nerve. Lastly clean the floor of the fossa by scraping away the fat from the popliteal surface of the femur with the handle of the scalpel. Clean also the oblique popliteal ligament and the fascia covering the popliteus at the lower part of the floor.

Contents.—The popliteal fossa contains the popliteal artery with its branches, the popliteal vein with its tributaries including the termination of the small saphenous vein, the tibial and common peroneal nerves with their branches given off in the popliteal fossa, the articular branch of the obturator nerve, the lower portion of the posterior femoral cutaneous nerve, a few lymph glands, and a large quantity of fat. The **floor** of the popliteal fossa is formed from above downwards by the popliteal surface of the femur, the oblique popliteal ligament of the knee joint, and the fascia covering the popliteus muscle at the back part of the upper end of the tibia.

The **Tibial Nerve** (internal popliteal nerve) is the larger of the two terminal branches of the sciatic nerve. It runs downwards along the middle line of the fossa and is the most superficially placed of all the important structures contained in the

space. Emerging from under cover of the biceps femoris it lies at first lateral to the popliteal vessels in the upper part of the popliteal fossa. In the middle of the fossa it crosses and lies behind the vessels and in the lower part, runs along their medial side.

The *branches* given off by the tibial nerve in the popliteal fossa are (1) cutaneous, (2) muscular, and (3) articular. (1) The *medial sural cutaneous nerve* (nervus communicans tibialis) arises opposite the middle of the fossa and runs in the groove between the two heads of the gastrocnemius in company with the small saphenous vein. It unites with the peroneal anastomotic branch at the back of the leg and forms the sural nerve which will be traced later on. (2) The *muscular branches* supply both heads of the gastrocnemius, plantaris, soleus and popliteus. The branch to the popliteus descends along the fascia covering its superficial surface and turns round the lower border of the muscle to gain its deep surface. (3) The *articular branches* three in number, arise in the upper part of the fossa; one of these accompanies the middle genicular artery and enters the middle of the oblique popliteal ligament; the other two accompany the superior and inferior medial genicular arteries.

The **Common Peroneal Nerve** (external popliteal nerve) is smaller than the tibial nerve. It passes downwards along the medial margin of the biceps femoris, then lies between the tendon of that muscle and the lateral head of the gastrocnemius and finally winds round the neck of the fibula to divide into two terminal branches, the superficial and deep peroneal nerves. Its branches are articular and cutaneous. Of the *articular branches* two accompany the superior and inferior lateral genicular branches of the popliteal artery. The third articular branch, called the *recurrent articular branch*, is given off near the termination of the nerve and hence is not found in the popliteal fossa. The cutaneous branches are two in number. (1) The *lateral sural cutaneous nerve* supplies the skin over the anterolateral aspect of the upper part of the leg. (2) The *peroneal anastomotic nerve* (nervus communicans fibularis) either arises separately or in common with the preceding nerve. It crosses the lateral head of the gastrocnemius to join the medial sural cutaneous nerve and form the sural nerve.

The *articular branch of the obturator nerve* is a fine filament which descends along the posterior aspect of the popliteal artery. It arises from the posterior branch of the obturator nerve and

appears in the popli teal fossa by piercing the lower fibres of the adductor magnus. It pierces the oblique popliteal ligament of the knee joint at about its centre and supplies the articular capsule.

Popliteal Lymph Glands.—These are six or seven in number. One lies superficially near the termination of the small saphenous vein into the popliteal vein. Its afferents accompany the small saphenous vein draining lymph from the lateral side of the foot and superficial part of the back of the leg. One lies deep between the popliteal artery and the oblique popliteal ligament. Its afferents are derived from the knee joint accompanying the genicular arteries. The remaining four or five glands lie along the sides of the popliteal vessels. Their afferents accompny the anterior and posterior tibial blood vessels. The efferents from all these popliteal lymph glands accompany the femoral vein and drain into the deep subingunial lymph glands.

The **Popliteal Artery** is the continuation of the femoral artery. It begins at the aperture in the adductor magnus and ends below at the lower border of the popliteus by dividing into anterior and posterior tibial arteries. The upper part of the artery has an oblique course and lies against the popliteal surface of the femur. The lower part of the artery has a straight vertical course and lies against the oblique popliteal ligament of the knee joint and the fascia covering the popliteus. It is covered by the semimembranosus above and by the gastrocnemius and plantaris below. The popliteal vein is firmly connected with the artery by dense fibrous tissue and so these vessels cannot be easily separated and cleaned. The relation of the vein to the artery is the same as that of the tibial nerve, viz., in the upper part of the fossa it lies laterally ; opposite the middle part it crosses the artery superficially ; and in the lower part it lies medial to the artery. Lastly on either side of the artery are the structures forming the side-walls of the popliteal fossa.

The **branches** of the popliteal artery are :—(1) The *muscular branches* which consist of a superior and an inferior group. The *superior muscular branches* are given off at the upper part of the fossa and supply the hamstring muscles. The *inferior muscular* or *sural branches* supply the gastrocnemius, the soleus and the plantaris. (2) The *cutaneous branches* arise from the popliteal artery or from its sural branches. They perforate the deep fascia to supply the skin over the upper part of the back of the leg. (3) The *genicular branches* are five in number, two superior,

two inferior, and one middle. The *medial superior genicular artery* (superior internal articular artery) arises from the popliteal artery above the level of the medial condyle of the femur and, passing transversely medialwards, winds round the femur beneath the semimembranosus and adductor magnus just above the origin of the medial head of the gastrocnemius. It then enters the substance of the vastus medialis. The *lateral superior genicular artery* (superior external articular artery) arises at the same level with the preceding branch and passes transversely lateralwards to wind round the femur beneath the biceps femoris above the origin of the lateral head of the gastrocnemius and the plantaris. It then enters the substance of the vastus intermedius. The *middle genicular artery* (azygos articular artery) arises from the popliteal artery opposite the bend of the knee joint and pierces the oblique popliteal ligament to supply the synovial stratum. The *medial inferior genicular artery* (inferior internal articular artery) passes medialwards along the upper margin of the popliteus and gains the front aspect of the limb beneath the tibial collateral ligament. The *lateral inferior genicular artery* (inferior external articular artery) passes lateralwards beneath the tendon of the biceps femoris and the fibular collateral ligament above the head of the fibula.

The **Popliteal Vein** begins at the lower border of the popliteus by the junction of the venæ comitantes of the anterior and posterior tibial arteries. It leaves the popliteal fossa through the aperture in the adductor magnus where it becomes the femoral vein. Its relations to the popliteal artery have been already described. Besides the tributaries corresponding to the branches of the artery, it receives the small saphenous vein at the lower part of the fossa.

THE BACK OF THE THIGH

The dissection of this region should be finished in one day.

Dissection. Make a vertical incision along the middle line of the back of the thigh through the skin that is left. Reflect the two flaps of skin on either side (Fig. 71).

The **Superficial Fascia** is fatty and in it the **Cutaneous Nerves** that are to be searched for are : (1) filaments from the *posterior femoral cutaneous nerve* along the middle line ; (2) twigs from the *posterior division of the lateral femoral cutaneous nerve* on the lateral side ; and (3, 4) filaments from the *medial femoral cuta-*

neous nerve and the *anterior division of the obturator nerve* on the medial side.

Reflect the superficial fascia in the same way as the skin.

The **Deep Fascia** is a part of the fascia lata of the thigh. It should be reflected in the same way as the superficial fascia. The hamstring muscles—the biceps femoris, the semimembranosus, and the semitendinosus—are now to be cleaned taking care of the posterior femoral cutaneous nerve which lies superficially.

The *posterior femoral cutaneous nerve* lies just under cover of the deep fascia. It descends along the middle line of the back of the thigh, superficial to the long head of the biceps femoris, to the popliteal fossa where it has been already examined.

The **Biceps Femoris** arises by two heads, a long and a short. The *long head* arises (1) from the lower and medial impression on the quadrilateral portion at the back part of the tuberosity of the ischium by a tendon which is common to it and the semitendinosus ; and (2) from the adjacent sacrotuberous ligament. The *short head* arises (1) from the lateral lip of the linea aspera below the insertion of the glutæus maximus and between the attachments of the adductor magnus and vastus lateralis ; (2) from the lower and lateral prolongation of the linea aspera in its upper two-thirds ; and (3) from the lateral intermuscular septum. The muscle formed by the union of the two heads ends in a tendon which passes downwards and lateralwards forming the upper and lateral boundary of the popliteal fossa. This tendon is inserted into the lateral surface of the head of the fibula and is divided into two portions, an anterior and a posterior, by the fibular collateral ligament. The anterior portion sends a slip which is inserted into the lateral condyle of the tibia. The posterior portion gives off an expansion which blends with the deep fascia of the leg. *Nerve-supply.*—The long head of the biceps femoris is supplied by the tibial portion of the sciatic nerve; the short head, by the common peroneal portion of the same nerve. *Actions.*—The biceps femoris flexes the knee and afterwards rotates the leg laterally. It also extends the hip joint.

The **Semitendinosus** arises from the lower and medial impression on the tuberosity of the ischium by a tendon common to it and the biceps femoris. The muscle ends at about the junction of the middle and lower thirds of the thigh in a long round tendon which passes downwards and medialwards forming

the upper and medial boundary of the popliteal fossa. The tendon crosses the tibial collateral ligament and is inserted into the upper part of the medial surface of the body of the tibia below the insertion of the gracilis and behind that of the sartorius. At its insertion it also gives off an expansion to the deep fascia of leg. A mucous bursa is interposed between the tendon and the tibial collateral ligament of the knee joint. The muscle usually presents a tendinous intersection at about its middle. It is supplied by the sciatic nerve. *Actions.*—It flexes the knee and afterwards rotates the leg medially. It also extends the hip joint.

The **Semimembranosus** receives its name from the membranous appearance of its tendon of origin. It arises by a flat tendon from the upper and lateral impression on the quadrilateral portion at the back part of the tuberosity of the ischium. The tendon of origin expands into an aponeurosis from which muscular fibres arise. The muscle passes downwards and medialwards and ends in the tendon of insertion which forms the medial boundary of the upper part of the popliteal fossa and is inserted (1) into the transverse groove at the back part of the medial condyle of the tibia ; (2) into the posterior surface of the lateral condyle of the femur by an expansion which passes upwards and lateralwards and forms the greater part of the oblique popliteal ligament ; and (3) into the oblique line at the upper part of the posterior surface of the tibia by a fibrous expansion which covers the popliteus muscle and (4) into the tibial collateral ligament of the knee joint by a third expansion. The muscle is supplied by the sciatic nerve. Its *actions* are similar to those of the semitendinosus—it flexes the knee and afterwards rotates the leg medially ; it also extends the hip joint.

Dissection. Divide the hamstring muscles at their origin and throw them downwards as far as practicable without injuring the vessels and nerves entering them. The sciatic nerve is now fully displayed. The adductor magnus is now exposed from behind. The attachment of this muscle to the femur and its relations to the four perforating arteries should be examined.

Sciatic Nerve.—In the back of the thigh this nerve is seen to lie between the adductor magnus in front and the long head of the biceps femoris behind. It divides usually at about the middle of the thigh into two terminal branches, the tibial and the common peroneal. Before its division it gives off muscular

branches to the semitendinosus, both heads of the biceps femoris, semimembranosus, and adductor magnus.

The **Perforating Arteries** are usually three in number and are derived from the arteria profunda femoris. They appear at the back of the thigh by passing backwards through tendinous arches in the adductor magnus close to the linea aspera. The *first perforating artery* perforates the upper part of the adductor magnus, supplies the hamstring muscles and sends an ascending branch which takes part in the crucial anastomosis by anastomosing with the inferior gluteal, and medial and lateral femoral circumflex arteries. It sends a descending branch to anastomose with the second perforating artery. The *second perforating artery* supplies the hamstring muscles and anastomoses with the first perforating artery above and the third perforating artery below. It gives off the nutrient artery of the femur. The *third perforating artery* supplies the hamstring muscles and anastomoses with the second perforating artery above and the terminal branch of the arteria profunda femoris below.

The *terminal branch of the arteria profunda femoris* pierces the adductor magnus a little above the aperture in the muscle for the femoral artery. It anastomoses above with the third perforating artery and below with the muscular branches of the popliteal artery. It is sometimes described as the *fourth perforating artery*.

Note. It should be noted that (1) the first perforating branch pierces the insertion of the glutæus maximus; (2) the other three pierce the short head of the biceps femoris and the lateral intermuscular septum; (3) the perforating arteries pass through tendinous arches in the adductor magnus and are thereby protected during the contraction of the muscle; and (4) by these perforating arteries a continuity of the anastomotic chain is kept up from the gluteal region to the popliteal fossa along the back of the thigh.

The companion *veins* of the perforating arteries terminate in the vena profunda femoris.

Crucial anastomosis.—This arterial anastomosis is formed at the upper and back part of the thigh by the anastomotic branch of the inferior gluteal artery superiorly; the ascending branch of the first perforating artery inferiorly; the transverse branch of the lateral femoral circumflex artery laterally; and the terminal superficial branch of the medial femoral circumflex artery medially.

THE FRONT OF THE THIGH

Dissections. Devote four days to the dissection of this region. The subject should be placed upon its back with blocks under the pelvis. The lower limb should be stretched out and rotated outwards.

Surface Anatomy.—The furrow which demarcates the front of the thigh from the abdomen corresponds to the position of the inguinal ligament which can be felt as a tense band stretching from the anterior superior iliac spine to the pubic tubercle. The subcutaneous inguinal ring lies medial to the pubic tubercle and the femoral ring lies lateral to it. Lymph glands can sometimes be felt along the line of the inguinal ligament as also below its central part for a short distance vertically. In front of the thigh and just below the inguinal ligament is a triangular depression with its base directed towards the abdomen. It corresponds to the femoral triangle. The greater trochanter of the femur can be recognised on the lateral aspect of the hip, from three to four inches below and behind the anterior part of the iliac crest. The head of the femur should be felt by rotating the limb medialwards and lateralwards and placing the thumb of one hand in front in the hollow below the inguinal ligament and the fingers behind the greater trochanter. In front of the knee the patella can be felt, as also the condyles of the femur on either side ; if the joint is half bent the condyles of the tibia and the head of the fibula can be easily palpated. Below the patella the tuberosity of the tibia is readily felt.

Dissection. The following incisions are required (Fig. 4) :—(1) An oblique incision from the symphysis pubis along the inguinal ligament to the anterior superior iliac spine ; (2) a transverse incision across the middle of the thigh ; (3) a vertical incision joining the medial end of the first incision to the medial end of the second along the medial border of the thigh ; (4) a transverse incision below the tuberosity of the tibia from the medial to the lateral aspect of the limb ; (5) a vertical incision along the middle line of the thigh connecting the midpoints of the two transverse incisions. Reflect the flap of skin above the upper transverse incision lateralwards. Reflect the flaps of skin between the two transverse incisions on either side. While reflecting the skin the student will notice two *bursæ* : (1) a bursa placed between the patella and the skin ; (2) a bursa interposed between the lower part of the tuberosity of the tibia and the skin.

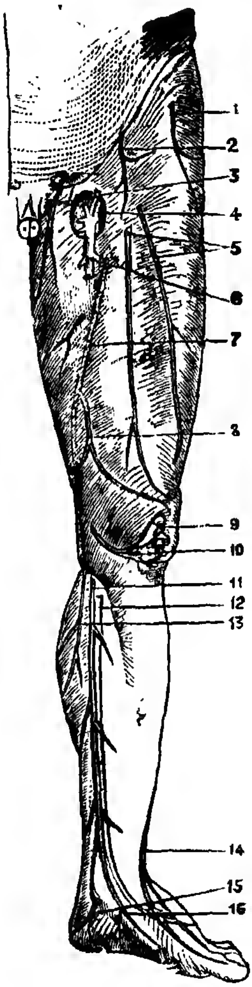
The **Superficial Fascia** is fatty and immediately below the inguinal ligament two layers in it can be demonstrated. The superficial fatty layer is continuous with the similar layer (fascia of Camper) in the anterior abdominal wall (p. 17). The deep layer is membranous in character, is continuous with the fascia of Scarpa in the anterior abdominal wall and is blended just below the inguinal ligament with the deep fascia of the thigh. This attachment can be demonstrated by pushing the handle of the knife downwards beneath it.

Dissection. Commence by displaying the cutaneous nerves. The lumboinguinal nerve pierces the faseia lata about an inch below the middle of the inguinal ligament. Find the ilioinguinal nerve near the medial end of the inguinal ligament. Seek for the anterior branch of the lateral femoral cutaneous nerve about four inches below the anterior superior iliac spine where it pierces the faseia lata. The posterior division of the same nerve will be seen piercing the deep fascia on a higher level. Secure the the intermediate femoral cutaneous nerve about four inches below the middle of the inguinal ligament and find its medial and lateral branches. The anterior and posterior branches of the medial femoral cutaneous nerve and the cutaneous filaments of the undivided trunk are then to be dissected out along the medial side of the front of the thigh as they accompany the great saphenous vein The anterior branch appears in the lower third of the thigh in front of the vein and the posterior branch behind the vein a little lower down. The saphenous nerve and its infrapatellar branch are seen to pierce the deep fascia on the medial side of the knee. Next trace the two branches of the intermediate femoral cutaneous nerve, and the anterior branches of the medial and lateral femoral cutaneous nerves which go to form the patellar plexus around the patella and demonstrate the formation of that plexus with the infrapatellar branch of the saphenous nerve. Then clean the superficial vessels and lymph glands. The great saphenous vein is to be traced upwards through the superficial fascia along the anteromedial side of the thigh, till it pierces the deep fascia in an oval area, called the fossa ovalis, a little below the inguinal ligament. Do not injure the branehes of the medial femoral eutaneous nerve found along the course of the vein. Note the lymph glands near the terminal part of the vessel before it pierces the deep fascia. Connected with these lymph glands many thread like bands will be seen. These are the lymphatic vessels

carrying lymph to and from the lymph glands. Another chain of lymph glands will be seen embedded in the superficial fascia close to the inguinal ligament. The three superficial veins which open into the saphenous vein near its termination are to be dissected out. They accompany the corresponding arteries, viz. the superficial external pudendal, the superficial epigastric, and the superficial circumflex iliac arteries. Of these the superficial external pudendal artery passes upwards and medialwards towards the subcutaneous inguinal ring; the superficial epigastric artery passes upwards to cross the middle of the inguinal ligament and the superficial circumflex iliac artery passes upwards and lateralwards towards the anterior superior iliac spine.

Cutaneous Nerves (Fig. 170).—(1) The *lumboinguinal nerve* (crural branch of the genitocrural nerve) pierces the deep fascia about an inch below the middle of the inguinal ligament on the lateral side of the femoral artery. It supplies the skin over the femoral triangle and communicates with the intermediate femoral cutaneous nerve. (2) The *ilioinguinal nerve* emerges through the subcutaneous inguinal ring (p. 18) and supplies the skin at the upper and medial side of the thigh near the scrotum or labium majus. (3) The *lateral femoral cutaneous nerve* splits into two branches, an anterior and a posterior. The *anterior branch* pierces the fascia lata about four inches below the lateral end of the inguinal ligament and descends along the lateral aspect of the front of the thigh as low as the patella where it joins the patellar plexus. It supplies the skin on the lateral aspect of the thigh. The *posterior branch* pierces the fascia lata about two inches below the anterior superior iliac spine. It supplies the skin of the lower part of the gluteal region and the lateral aspect of the upper part of the thigh. (4) The *intermediate femoral cutaneous nerve* (middle cutaneous nerve) is a branch of the femoral nerve. It becomes cutaneous by piercing the deep fascia in the middle line about four inches below the inguinal ligament. It soon divides into a medial and a lateral branch; both of which descend in front of the thigh as low as the patella and join the patellar plexus. Sometimes the nerve divides beneath the deep fascia into two branches which pierce the deep fascia separately. (5) The *medial femoral cutaneous nerve* (internal cutaneous nerve) is also derived from the femoral nerve. It divides into two branches, an anterior and a posterior. The *anterior branch* pierces the deep fascia at the antero-medial aspect of the lower third of the thigh and ends by joining the

patellar plexus. The *posterior branch* pierces the deep fascia over the medial condyle of the femur and is distributed to the



1. Lateral femoral cutaneous nerve.
2. Lumboinguinal nerve.
3. Ilioinguinal nerve.
4. Fossa ovalis.
5. Intermediate femoral cutaneous nerve.
6. Great saphenous vein.
7. Medial emoral cutaneous nerve.
8. Anterior branch of medial femoral cutaneous nerve.
9. Patellar plexus of nerves.
10. Infrapatellar nerve.
11. Saphenous nerve.
12. Great saphenous vein.
13. Posterior branch of medial femoral cutaneous nerve.
14. Superficial perineal nerve.
15. Medial calcaneal nerve.
16. Saphenous nerve (terminal part).

Fig. 170.—Cutaneous nerves of the inferior extremity —anterior view (from Buchanan).

integument on the medial side of the upper part of the leg. Some cutaneous filaments pierce the deep fascia along the course of the great saphenous vein in the upper part of the thigh. These are derived from the undivided trunk of the medial femoral

cutaneous nerve. (6) The *saphenous nerve* (long or internal saphenous nerve) is a branch of the femoral nerve. It becomes cutaneous by perforating the deep fascia on the medial side of the knee. Before it becomes cutaneous it gives off the *infra-patellar branch* which pierces the deep fascia on the medial side of the knee and supplies the skin in front of the patella. The infrapatellar nerve communicates above with the cutaneous branches of the femoral nerve, and laterally with the branches of the lateral femoral cutaneous nerve.

The *patellar plexus* is formed by the communication with each other of the following nerves in front of and around the patella :—(1) the two branches of the intermediate femoral cutaneous nerve in front of the knee along the middle line ; (2) the anterior branch of the lateral femoral cutaneous nerve along the lateral side ; (3) the anterior branch of the medial femoral cutaneous nerve along the medial side ; and (4) the infrapatellar branch of the saphenous nerve below the patella.

Superficial Vessels.—These are three in number and arise from the femoral artery below the inguinal ligament. (1) The *superficial circumflex iliac artery* pierces the deep fascia lateral to the fossa ovalis and passes upwards and lateralwards towards the anterior superior iliac spine. (2) The *superficial epigastric artery* passes through the fascia cribrosa, crosses the inguinal ligament and proceeds upwards to the anterior abdominal wall (p. 20). (3) The *superficial external pudendal artery* pierces the fascia cribrosa and passes upwards and medialwards towards the subcutaneous inguinal ring (p. 20). The companion *veins* of these arteries open into the terminal part of the great saphenous vein and not into the femoral vein direct.

The **Great Saphenous Vein** (internal saphenous vein) lies superficially in its course along the thigh. In the present dissection it appears behind the medial condyle of the tibia and ascends behind the medial condyle of the femur and then along the antero-medial aspect of the thigh. Reaching the fossa ovalis it pierces the fascia cribrosa and terminates in the femoral vein. In the thigh it receives many tributaries from the anterior, medial and posterior aspects of the thigh. Sometimes some tributaries from the medial and posterior aspects of the thigh join to form an accessory saphenous vein before opening into the great saphenous vein. Before it passes through the fossa ovalis it receives the superficial circumflex iliac, epigastric, and external pudendal veins.

The **Inguinal Lymph Glands** are divisible into three groups. (1) The *superficial inguinal lymph glands* lie immediately below the inguinal ligament and receive lymph vessels from the penis, scrotum, perineum, anal canal, buttock, and the lower part of the anterior abdominal wall. (2) The *superficial subinguinal lymph glands* lie on either side of the terminal part of the great saphenous vein. They receive the superficial lymph vessels of the greater part of the inferior extremity and also some of the vessels of the skin of the penis, scrotum and perineum. The efferents from both of these groups pierce the fossa ovalis and fascia lata and drain into the deep subinguinal lymph glands. (3) The *deep subinguinal lymph glands* will be studied later on.

Dissection. Remove the superficial lymph glands and the superficial fascia. Clean the surface of the fascia lata or deep fascia of the thigh. An oval opening in the fascia lata will be seen below the inguinal ligament. This is the fossa ovalis ; it is closed by a thin layer of fascia called the fascia cribrosa. Take care that this layer of fascia is not injured.

The **Fascia Lata** or the deep fascia of the thigh forms a covering for the whole of the thigh. Above and in front it is attached to the inguinal ligament and the medial part of the superior ramus of the os pubis. Above and behind it forms the deep fascia of the gluteal region, the attachment of which has been described (p. 555). Above and medially it is attached to the inferior rami of the os pubis and ischium and to the ischial tuberosity. Below it is attached to all the bony prominences around the knee joint, viz., the condyles of the femur and tibia, the borders of the patella, and the head of the fibula. The thickness of the fascia lata varies in different parts. At the lateral aspect of the thigh it is very thick and strong and a special strong band, called the *iliotibial tract*, is formed in it, owing to its receiving the insertions of the glutaeus maximus and the tensor fasciæ latæ. Below, the fascia lata is strengthened in front of the knee by expansions from the tendon of the quadriceps femoris. Behind the knee, it is continuous with the deep fascia covering the popliteal fossa. Here it receives an expansion from the tendon of the biceps femoris. The medial portion of the fascia lata which covers the adductor muscles is very thin. At the upper and front of the thigh the fascia lata consists of two portions, a superficial or iliac portion and a deep or pectineal portion (pubic portion).

This division into two portions extends to a limited extent only—up to the lower margin of the fossa ovalis. The *iliac portion* lies on the lateral side of the fossa ovalis and is attached above to the inguinal ligament and pecten pubis ; its medial limit is formed by the falciform margin of the fossa ovalis —this margin becomes attached to the anterior layer of the femoral sheath. The *pectineal portion* or *fascia pectinea* lies on the medial side of the fossa ovalis and covers the adductor longus and pectineus. Traced laterally it becomes blended with the posterior layer of the femoral sheath, is found to be continuous with the fascia iliaca which covers the iliopsoas muscle and becomes attached to the pecten pubis. It follows therefore that the iliac portion lies anterior to the femoral sheath and the pectineal portion lies posterior to the sheath.

From the deep surface of the fascia lata numerous intermuscular septa are given off, which form sheaths for and separate individual muscles. Three of these septa, lateral, medial and posterior, will be examined at a later stage of dissection. Of these three the lateral and medial septa are specially strong, the former separates the extensor muscles from the hamstrings and the latter separates the extensors from the adductors.

PARTS CONCERNED IN FEMORAL HERNIA

Dissection. If the student has to perform a special dissection of the parts concerned in femoral hernia he should reflect the skin from the upper fourth of the front of the thigh by the following incisions : (1) an oblique incision from the anterior superior iliac spine to the symphysis pubis ; (2) a transverse incision across the front of the thigh at the junction of its upper fourth with the lower three fourths ; (3) a vertical incision joining the medial ends of the two incisions along the medial border of the thigh. Reflect the flap of skin laterally. Then reflect the superficial fascia together with the lymph glands without injuring the blood vessels and the thin layer of fascia (fascia cribrosa) covering the fossa ovalis.

The **Fossa Ovalis** (saphenous opening) is an oval aperture in the fascia lata at the upper and medial part of the thigh below the medial half of the inguinal ligament. It is about an inch and a half long, and half an inch in breadth. It is bounded laterally by the sharp medial margin of the iliac portion of the fascia lata, called the *falciform margin*, which presents two cornua,

a superior and an inferior. The *superior cornu* passes upwards and medialwards to be attached to the inguinal ligament. The *inferior cornu* becomes continuous below the opening with the pectineal portion of the fascia lata. The fossa ovalis is closed by a thin fascia, called the *fascia cribrosa* (cribriform fascia), which is so named on account of its being perforated by vessels like a sieve. This fascia is attached laterally to the falciform margin and medially it becomes continuous with the front of the pectineal fascia; it is perforated by the superficial epigastric and superficial external pudendal arteries, the great saphenous vein and by the efferent lymph vessels which proceed from the

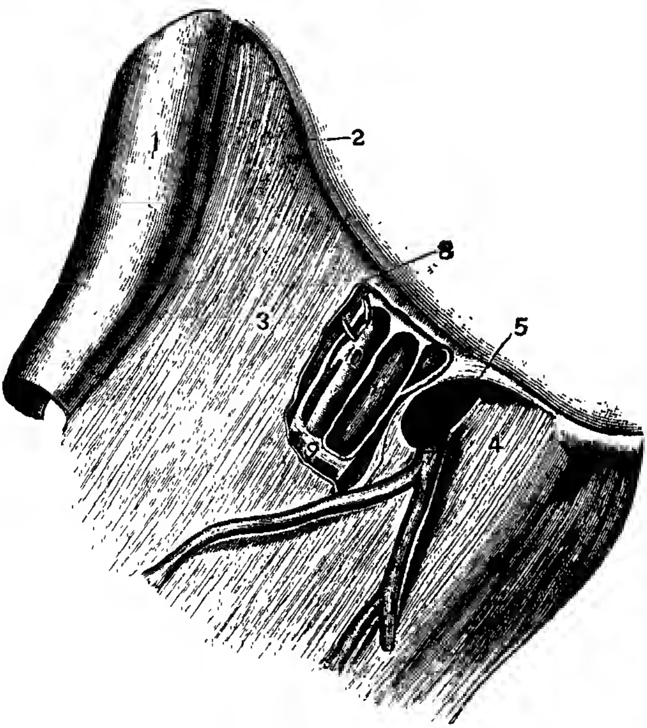


Fig. 171.—Dissection of the region concerned in femoral hernia. (After Gray).

1. Skin reflected.
2. Inguinal ligament.
3. Superficial portion of fascia lata.
4. Deep portion of fascia lata.
5. Fossa ovalis.
6. Fascia cribrosa.
7. Great saphenous vein.
8. Fascia lata (cut).
9. Anterior layer of femoral sheath.
10. Femoral artery.
11. Femoral vein.
12. Femoral canal.

superficial subinguinal and inguinal lymph glands to end in the deep subinguinal lymph glands.

Dissection. Make a vertical incision about two inches in length through the iliac portion of the fascia lata beginning from the inguinal ligament about an inch lateral to its midpoint and terminating about half an inch below the lower end of the fossa ovalis. Make an incision through the fascia lata along the lower border of the inguinal ligament medial to the vertical incision, leaving the attachment of the superior cornu of the falciform margin to that ligament intact. Reflect the piece of fascia lata marked out by the two incisions medialwards. On removing the loose fat, the femoral sheath is exposed as it descends into the thigh beneath the inguinal ligament. With the handle of the scalpel the femoral sheath is to be separated carefully from the inguinal ligament in front and from the lacunar ligament on the medial side. Note that the sheath is blended behind with the pectineal fascia from which it cannot be isolated.

The **Femoral Sheath** (crural sheath) is a funnel shaped sheath containing the femoral vessels and extends from the inguinal ligament above to the lower end of the fossa ovalis below. Its upper wide end is directed towards the abdomen. Its lower narrow end fuses with the coats of the femoral vessels at the lower end of the fossa ovalis. The *anterior wall* of the sheath is formed by a prolongation of the fascia transversalis from the anterior abdominal wall. The *posterior wall* of the sheath is formed by a prolongation of the fascia iliaca from the posterior abdominal wall and is blended with the pectineal portion of the fascia lata. The *lateral wall* is straight and is pierced by the lumboinguinal nerve. The *medial wall* is oblique and is pierced by the great saphenous vein and lymphatic vessels. The sheath is subdivided into three compartments by two anteroposterior septa stretching between its anterior and posterior walls. The lateral compartment contains the femoral artery and the lumboinguinal nerve, the intermediate is occupied by the femoral vein ; and the medial, called the femoral canal, contains a lymph gland, some lymphatic vessels and areolar tissue.

Dissection. Open up the three compartments by making three vertical incisions through the anterior wall of the sheath. The vertical incisions to open up the lateral and intermediate compartments of the femoral sheath should extend throughout the whole length of the sheath along the course of the femoral artery and the femoral vein. The vertical incision over the

most medial compartment should be made about half an inch medial to the incision over the femoral vein and should extend downwards for half an inch only from the inguinal ligament.

The **Femoral Canal** (crural canal) is the most medial compartment of the femoral sheath and is so named on account of its special relation to femoral hernia. It is about half an inch in length and extends from the inguinal ligament to the upper end of the fossa ovalis. Its base is directed upwards and is called the *femoral ring* (crural ring). This ring is oval in shape; its transverse diameter measures about half an inch; it is bounded in front by the inguinal ligament, behind by the fascia covering the pectineus, medially by the concave base of the lacunar ligament, and laterally by the femoral vein. Above the anterior margin of the ring is seen the spermatic cord or the round ligament of the uterus; near its upper limit are the inferior epigastric vessels. The ring is closed normally by condensed extraperitoneal connective tissue called the *septum femorale*. The upper surface of this septum is lined by peritoneum and presents a depression, called the *femoral fossa*, when viewed from the abdominal cavity.

The term *femoral hernia* is employed to denote the protrusion of some of the contents of the abdominal cavity into the thigh through the femoral ring and canal. The student can now understand the coverings which such a protrusion gets in its descent into the thigh. These are from within outwards: (1) peritoneum, which forms the sac of the hernia; (2) septum femorale; (3) anterior wall of the femoral sheath; (4) fascia cribrosa; (5) superficial fascia; and (6) skin.

The student can now obtain a good view of the lacunnar ligament and should study its relations and attachments. It has been described fully on p. 22.

DEEP PARTS OF THE FRONT OF THE THIGH

Dissection. Extend the vertical incision made in the fascia lata downwards up to the inferior limit of the tuberosity of the tibia and remove the whole of the fascia medial to the incision. The iliotibial tract should be left intact. Next dissect the boundaries and contents of the femoral triangle. Begin by cleaning the sartorius and take care that the lateral femoral cutaneous nerve which crosses the muscle below the anterior superior iliac spine and the intermediate femoral cutaneous nerve which either

crosses or pierces the muscle, are not injured. Clean the other muscular boundary, the adductor longus. Next dissect the femoral artery. Begin by removing the femoral sheath taking care that the nerve to the pectineus which passes from the lateral to the medial side behind the sheath is not injured. Follow the three superficial branches of the femoral artery to the main trunk. The deep external pudendal artery which arises from the medial side of the femoral artery, the profunda femoris branch which arises from its back part, and the medial and lateral femoral circumflex branches of the profunda artery are then to be dissected out. Clean the femoral and profunda veins and their tributaries which are found in this triangular space. Then lift the femoral nerve from the groove between the iliacus and the psoas major by passing the handle of a scalpel and clean the various branches which are seen in this space Trace the intermediate and medial femoral cutaneous nerves to their origin from the femoral nerve. The saphenous nerve will be seen accompanying the femoral artery to the adductor canal. Trace the muscular branches to the rectus femoris, sartorius and the vasti. The nerve to the pectineus will be seen passing downwards and medialwards from the femoral nerve behind the femoral sheath to enter the pectineus.

The **Femoral Triangle** (Scarpa's Triangle) is a triangular space in front of the upper third of the thigh It is *bounded* laterally by the medial border of the sartorius ; medially by the medial border of the adductor longus ; above by the inguinal ligament which constitutes its *base* ; its *apex* corresponds to the meeting point of the sartorius and the adductor longus.

The **Contents** of the femoral triangle are : (1) the femoral artery with (*a*) its three superficial branches, (*b*) its deep external pudendal branch, and (*c*) its profunda femoris branch ; the medial and lateral femoral circumflex branches of the profunda femoris. (2) The femoral vein with its tributaries including the great saphenous vein which receive the veins corresponding to the three superficial branches of the femoral artery. (3) The femoral nerve and its branches ; the lumboinguinal nerve ; the lateral femoral cutaneous nerve. (4) Deep femoral lymphatic vessels : deep subinguinal lymph glands. (5) Fatty tissue.

The structures forming the **floor** of the femoral triangle, from the lateral to the medial side, are :—the iliacus, the psoas major, the pectineus and the adductor longus. If the contiguous

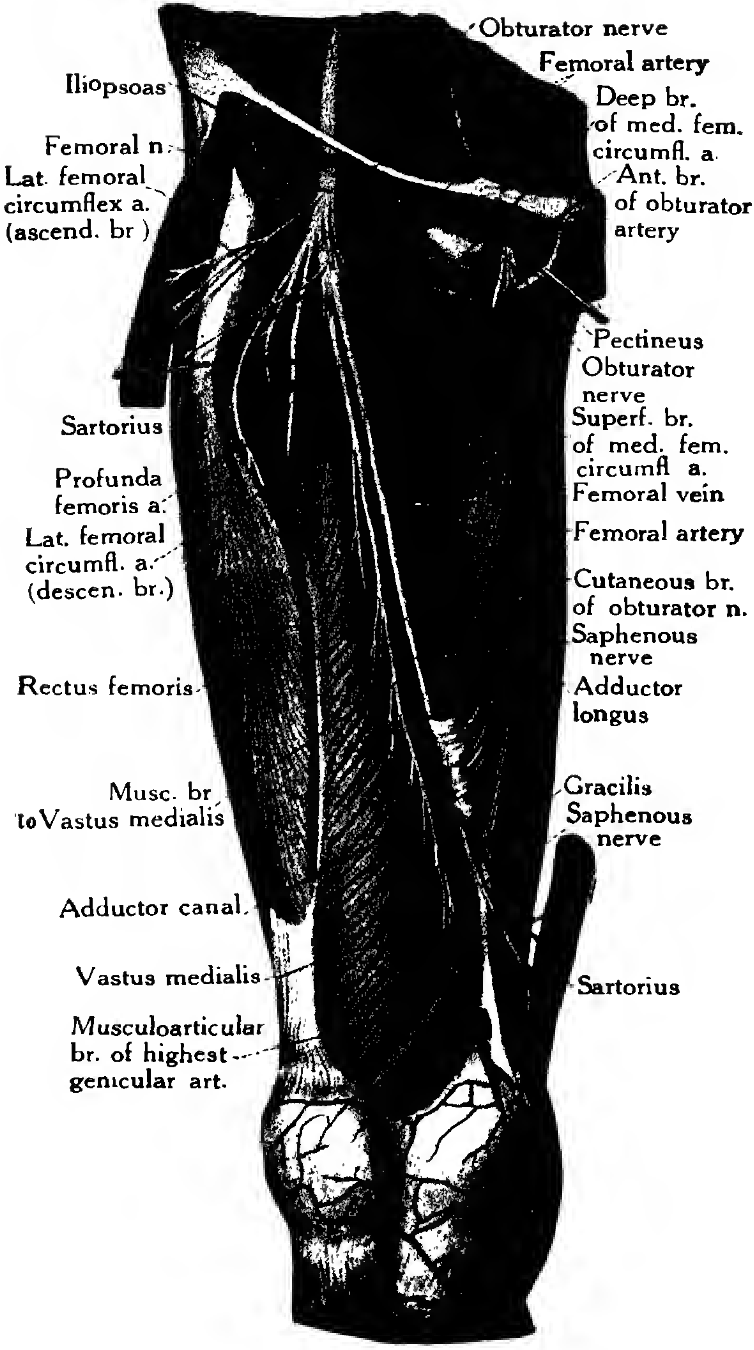


Fig. 172.—Dissection of the front of the thigh (Sobotta).

XLV

To face P. 584

borders of the pectineus and adductor longus do not meet, a part of the adductor brevis is seen.

The **Femoral Artery** is the continuation into the thigh of the external iliac artery. It begins behind the midpoint of the inguinal ligament and extends through the upper two-thirds of the thigh to terminate in the opening of the adductor magnus where it becomes the popliteal artery. Its upper part is contained in the femoral triangle ; its lower part in the adductor canal. In its upper part it lies medial to the head of the femur and is comparatively superficial and is not covered by muscles ; lower down it is placed along the medial side of the shaft of the femur and lies beneath the sartorius. In the femoral triangle it extends from the midpoint of the inguinal ligament to the apex of the triangle. Here it is rather superficial being covered by the skin, superficial fascia, fascia lata ; and the anterior wall of the femoral sheath at the upper part. It is crossed near the apex of the triangle by the medial femoral cutaneous nerve. The lumbo-inguinal nerve lies at first in front of the artery within the femoral sheath and then lateral to the artery. Behind it are the posterior wall of the femoral sheath, the pectineal fascia the psoas major, the pectineus with its nerve, and the profunda femoral vessels. It is separated from the adductor longus by the femoral vein ; from the pectineus by the profunda vessels and the femoral vein ; from the capsule of the hip joint by the psoas major. Lateral to it is the femoral nerve. Medially is the femoral vein which passes behind the artery near the apex of the triangle.

Branches.—In the femoral triangle the femoral artery gives off :—(1) the *superficial iliac circumflex,* (2) the *superficial epigastric,* and (3) the *superficial external pudendal arteries.* These have been described (p. 20). (4) The *deep external pudendal artery* (deep external pudic artery) passes medialwards and, crossing the pectineus and adductor longus, pierces the fascia lata on the medial side of the thigh to supply the skin of the scrotum or labium majus. (5) The *arteria profunda femoris* is a large vessel which arises from the lateral aspect of the femoral artery about an inch and a half below the inguinal ligament. At first it is placed lateral to the femoral artery and lies over the iliacus. It next proceeds downwards and medialwards so that it lies behind the femoral vessels and upon the pectineus. It then proceeds downwards behind the adductor longus and disappears from the present dissection. The origins of two

of its branches are now seen. These are the lateral and medial femoral circumflex arteries. The *lateral femoral circumflex artery* arises from the lateral aspect of the parent trunk and passes laterally behind the sartorius and rectus femoris. Its termination in ascending, descending, and transverse branches will be examined in a subsequent stage of the dissection. The *medial femoral circumflex artery* arises from the medial and back part of the parent trunk and disappears from the present dissection by passing backwards between the psoas major and the pectineus.

Veins.—In the femoral triangle, (1) the *great saphenous vein* receives the veins corresponding to the three superficial inguinal branches of the femoral artery and opens into the femoral vein. (2) The veins corresponding to the remaining branches of the femoral artery open directly into the *femoral vein*.

The **Nerves** in the femoral triangle are: (1) The *lumboinguinal nerve* lies at first in front of and then lateral to the femoral artery in the lateral compartment of the femoral sheath. It then pierces the lateral wall of the sheath and the fascia lata and becomes cutaneous (p. 576). (2) The *lateral femoral cutaneous nerve* enters the upper and lateral angle of the femoral triangle through the notch just below the anterior superior iliac spine. It soon leaves the triangle, crosses the sartorius and becomes cutaneous by piercing the fascia lata (p. 576). (3) The *femoral nerve* lies on the lateral side of the femoral artery and soon divides into an anterior and a posterior division.

Deep subinguinal lymph glands.—These lie on the medial side of the femoral vein and vary from one to three in number: one lies in the femoral canal which has been already seen; the second, when present, occupies the femoral ring; and the third lies on the medial side of the femoral vein below its junction with the great saphenous vein. Their afferents are the deep lymphatic vessels accompanying the femoral vessels. They also receive the lymphatic vessels which come from the superficial subinguinal lymph glands through the fascia cribrosa. Their efferents drain into the external iliac lymph glands.

Dissection. The adductor canal lies in the middle third of the thigh covered by the sartorius. To expose the canal the sartorius is to be pulled laterally and fixed with hooks. Beneath the sartorius is seen an aponeurosis which stretches from the vastus medialis laterally, to the adductores longus and magnus medially, and forms the roof of the canal. Above, the roof

extends up to the apex of the femoral triangle and below, it ends in a well-defined margin between the vastus medialis and the aperture for the femoral artery in the adductor magnus. A plexus of nerves, called the *subsartorial plexus*, lies over this aponeurotic roof. This plexus is formed by filaments from the posterior branch of the medial femoral cutaneous nerve, the anterior branch of the obturator nerve which emerges from the lower border of the adductor longus and a filament from the saphenous nerve ; the last-named nerve pierces the aponeurotic roof of the canal to join the plexus. Clean the aponeurotic roof taking care to preserve the nerves of the subsartorial plexus. When the roof and the plexus have been examined, display the canal by making a longitudinal incision through the roof from the point where it begins to the point where it ends.

The **Adductor Canal** (Hunter's canal) is a musculo-aponeurotic tunnel which occupies the middle third of the thigh. It extends from the apex of the femoral triangle to the aperture in the adductor magnus for the femoral vessels. It is bounded anterolaterally by the vastus medialis, posteromedially by the adductor longus above and adductor magnus below. Its *roof* is formed by an aponeurosis stretching from the adductores longus and magnus to the vastus medialis. The roof is covered by the sartorius and the subsartorial plexus. The canal is triangular on transverse section with the apex at the linea aspera and the base at the roof.

The **Contents** of the adductor canal are the femoral artery and some of its muscular branches and the highest genicular artery, the femoral vein, the saphenous nerve and the nerve to the vastus medialis. The femoral vein lies behind the artery in the upper part of the canal and laterally at the lower part. The saphenous nerve lies at first lateral to the femoral artery but lower down crosses it to gain its medial side. The nerve to the vastus medialis lies against the surface of the muscle. The highest genicular artery arises from the femoral artery just before it leaves the adductor canal.

The **Femoral Artery** is deeply placed in the adductor canal. Besides the skin and fascia it has *in front* the sartorius, subsartorial plexus, the aponeurotic covering of the adductor canal, and the saphenous nerve. *Behind* it are the adductores longus and magnus and the femoral vein at the upper part. *Lateral* to it are the vastus medialis, the saphenous nerve at the upper part, and the femoral vein at the lower part.

The **branches** of the femoral artery in the adductor canal are :—(1) *Muscular branches* which supply the neighbouring muscles. (2) The *highest genicular artery* (anastomotica magna) arises just before the femoral artery leaves the adductor canal. It soon divides into two branches, a saphenous branch and a musculoarticular branch. The *saphenous branch* pierces the aponeurotic roof of the adductor canal and accompanies the saphenous nerve to the medial side of the upper part of the leg where it anastomoses with the medial inferior genicular branch of the popliteal artery. The *musculoarticular branch* descends along the medial side of the thigh through the substance of the vastus medialis and anastomoses with the medial superior genicular branch of the popliteal artery. From it a branch passes laterally above the patellar surface of the femur and anastomoses with the lateral superior genicular artery forming an anastomotic arch.

The **Femoral Vein** begins at the opening in the adductor magnus as the direct continuation of the popliteal vein. It ends behind the inguinal ligament and becomes the external iliac vein. It lies medial to the femoral artery in the upper part of the femoral triangle where it occupies the intermediate compartment of the femoral sheath ; in the lower part of the femoral triangle and in the upper part of the adductor canal it lies behind the artery ; in the lower part of the adductor canal it lies lateral to the artery. Its tributaries are : (1) the great saphenous vein which again receives the three veins corresponding to the three superficial inguinal branches of the femoral artery, (2) the veins corresponding to the remaining branches of the femoral artery both in the femoral triangle and the adductor canal.

The **Femoral Nerve** is a branch of the lumbar plexus. It passes beneath the inguinal ligament and enters the femoral triangle where it lies lateral to the femoral artery and is separated from the artery by a small portion of the psoas major. It soon divides into an anterior and a posterior division. The *anterior division* gives off muscular and cutaneous branches. The *muscular branches* are :—(1) The *nerve to the pectineus* which passes medialwards behind the femoral sheath to supply the muscle. (2) The *nerve to the sartorius* arises usually in common with the intermediate femoral cutaneous nerve and supplies the muscle. The *cutaneous branches* are :—(1) The ***intermediate femoral cutaneous nerve*** which divides into two branches,

medial and lateral, soon after its origin. The lateral branch usually pierces the sartorius and supplies it. The distributions of these branches have been examined (p. 576). (2) The *medial femoral cutaneous nerve* crosses the femoral artery from the lateral to the medial side at the apex of the femoral triangle and divides into an anterior and a posterior branch. The *anterior branch* descends in front of the sartorius and pierces the fascia lata at the medial part of the lower third of the thigh. Its subsequent course has been examined (p. 576). The *posterior branch* descends along the medial border of the sartorius, gives off a filament which joins the subsartorial plexus and perforates the fascia lata at the medial side of the knee. Its subsequent distribution has been examined (p. 577).

The *posterior division of the femoral nerve* gives off the saphenous nerve and muscular branches. The *saphenous nerve* (internal or long saphenous nerve) lies on the lateral side of the femoral artery in the femoral triangle and at the upper part of the adductor canal. At the lower part of the canal it crosses in front of the femoral artery and gains its medial side. It leaves the canal through the lower part of its aponeurotic roof in company with with the saphenous branch of the highest genicular artery. It then passes downwards beneath the sartorius and, emerging from beneath that muscle at its posterior border, pierces the deep fascia at the medial side of the knee. Its subsequent course will be examined during the dissection of the leg. In the adductor canal it gives off a filament which pierces the aponeurotic roof of the canal and joins the subsartorial plexus. Before piercing the fascia lata it gives off the *infrapatellar branch* at the medial side of the knee which pierces the sartorius and the fascia lata and joins the patellar plexus. The muscular branches of the posterior division are :—(1) The *nerve to the rectus femoris* which enters its deep surface at the upper part and supplies a twig to the hip joint. (2) The *nerve to the vastus medialis* accompanies the saphenous nerve and enters the adductor canal; in the upper part of the adductor canal the nerve lies on the surface of the muscle. Then it enters into the substance of the muscle at about its middle and gives off a filament which supplies the knee joint. (3) The *nerve to the vastus lateralis* descends with the descending branch of the lateral femoral circumflex artery, supplies the muscle and sends a twig to supply the knee joint. (4) The *nerve to the vastus intermedius* are two or three in number and enter the anterior surface of the muscle. Of these the most medial

filament supplies the articularis genus and the knee joint by passing through the vastus intermedius.

Directions. The intermuscular septa of the fascia lata and the iliotibial tract can now be properly examined.

Three strong **intermuscular septa** pass from the deep surface of the fascia lata. The *lateral intermuscular septum* is strong and is attached to the lateral lip of the linea aspera and to its lower prolongation. It separates the vastus lateralis from the short head of biceps femoris. The *medial intermuscular septum* is thinner than the lateral and is attached to the medial lip of the linea aspera and to its lower prolongation. It separates the vastus medialis from the adductor muscles and the pectineus. The *posterior intermuscular septum* is the thinnest of the three and is placed between the adductor and hamstring muscles. Besides these other small processes are given off from the fascia lata which pass between the muscles.

The **iliotibial tract** stretches along the lateral aspect of the thigh. Above it is attached to the anterior part of the iliac crest and below (1) to an elevation on the lateral condyle of the tibia which extends from the fibular facet to the upper margin of the tuberosity, and (2) to the head of the fibula. It receives the insertion of the tensor fasciæ latæ and the greater part of the insertion of the glutæus maximus. The portion of the band corresponding to the origin of the tensor fasciæ latæ descends as two layers, one superficial and the other deep to the muscle, and at the lower limit of this muscle the two layers unite—thus the muscle is inserted at the line of union of the two layers of the tract. The glutæus maximus is inserted into the band posteriorly at the level of the greater trochanter. The band helps to steady the pelvis and keep the knee joint straight in standing.

Directions. The muscles in front of the thigh should now be cleaned and studied. Remove the portion of the fascia lata covering the surface of the tensor fasciæ latæ.

The **Tensor Fasciæ Latæ** (Tensor fasciæ femoris) arises (1) from the anterior part of the outer lip of the iliac crest to the extent of about an inch ; (2) from the outer aspect of the anterior superior iliac and the notch below it ; and (3) from the deep surface of the fascia lata. It lies between the two layers of the upper portion of the iliotibial tract and is inserted into the line of union of the two layers of the tract at the junction of the upper with the middle third of the thigh. It is supplied by the lower

branch of the superior gluteal nerve which enters its deep surface. It makes the fascia lata tense. It adducts the thigh and rotates it inwards.

The **Sartorius** is the longest muscle in the body ; it arises from the anterior superior iliac spine and from the upper half of the notch lying below it. It passes obliquely in front of the upper third of the thigh from the lateral to the medial side. It then proceeds almost vertically downwards to the medial side of the knee lying on the roof of the adductor canal opposite the middle third of the thigh. Its tendon of insertion expands into an aponeurosis which is inserted (1) into the upper part of the medial surface of the body of the tibia in front of the insertions of the gracilis and semitendinosus. It is also inserted (2) into the deep fascia of the leg by an expansion from its lower bordet and (3) into the articular capsule of the knee joint by an expansion from its upper margin. The muscle is supplied by a branch from the anterior division of the femoral nerve. It is a flexor of the knee and hip joints. It also rotates the leg inwards and the thigh outwards.

Dissection. Divide the iliotibial tract below the insertion of the tensor fasciæ latæ.

The **Quadriceps Femoris** is a large fleshy mass occupying the front of the thigh. It consists of four portions which unite at the lower part of the thigh to form a common tendon of insertion. The four portions are :—The rectus femoris placed in front and superficially, the vastus lateralis laterally, the vastus medialis medially, and the vastus intermedius covering the anterior and lateral surfaces of the femur.

The **Rectus Femoris** has two heads of origin. The *anterior* or *striaght head* arises by a tendon from the anterior inferior spine of the ilium. The *posterior* or *reflected head* arises by a tendon from the groove on the dorsum of the ilium above the acetabulum. The two heads unite into a single tendon which extends into an aponeurosis on the anterior surface of the muscle ; the muscular fibres take their origin from this aponeurosis from which a fusiform muscle is formed. Above the knee the muscle ends in a flattened tendon which is developed on the deep surface of the muscle. This tendon is then blended with the tendon of the vasti and is inserted into the upper border of the patella. The muscle is supplied by a branch from the posterior division of the femoral nerve.

The **Vastus Lateralis** (vastus externus) is the largest part

of the quadriceps femoris and is covered by an aponeurosis which extends over the upper three-fourths of the superficial surface of the muscle. By this aponeurosis it arises (1) from the upper part of the intertrochanteric line, (2) from the anterior and inferior margins of the greater trochanter, (3) from the lateral lip of the gluteal tuberosity, (4) from the upper half of the lateral lip of the linea aspera, and (5) from the lateral intermuscular septum. It ends below in a flattened tendon which is blended with the common tendon of the quadriceps femoris and is inserted into the lateral border of the patella. It gives an expansion to the articular capsule of the knee joint. It is supplied by a branch from the posterior division of the femoral nerve.

The **Vastus Medialis** (vastus internus) arises (1) from the lower half of the intertrochanteric line, (2) from the medial lip of the linea aspera and its prolongation below, (3) from the medial intermuscular septum, and (4) from the tendons of the adductor longus and adductor magnus. The fibres pass downwards and forwards and end in a tendon which is blended with the common tendon of the quadriceps femoris and is inserted into the medial border of the patella. It gives an expansion to the articular capsule of the knee joint. The muscle is supplied by a branch from the posterior division of the femoral nerve.

The **Vastus Intermedius** (crureus) arises (1) from the upper two-thirds of the anterior and lateral surfaces and the lateral border of the femur, and (2) from the lower part of the lateral intermuscular septum. It ends below in a tendon which forms part of the common tendon of the quadriceps femoris and is inserted into the upper border of the patella. The muscle gets its nerve-supply from the posterior division of the femoral nerve.

The **Tendon of the Quadriceps Femoris** is formed by the blending together of the tendons of the four divisions of the muscle. It is inserted into the base of the patella; the superficial fibres are prolonged over the anterior surface of the patella and become continuous with the ligamentum patellæ, thus gaining an insertion into the rough part of the tuberosity of the tibia. Expansions are given off from it on either side of the patella which blend with the articular capsule of the knee joint.

Dissection. Divide the rectus femoris at about its middle and reflect the lower part downwards. Make a longitudinal incision through the lower part of the vastus intermedius on

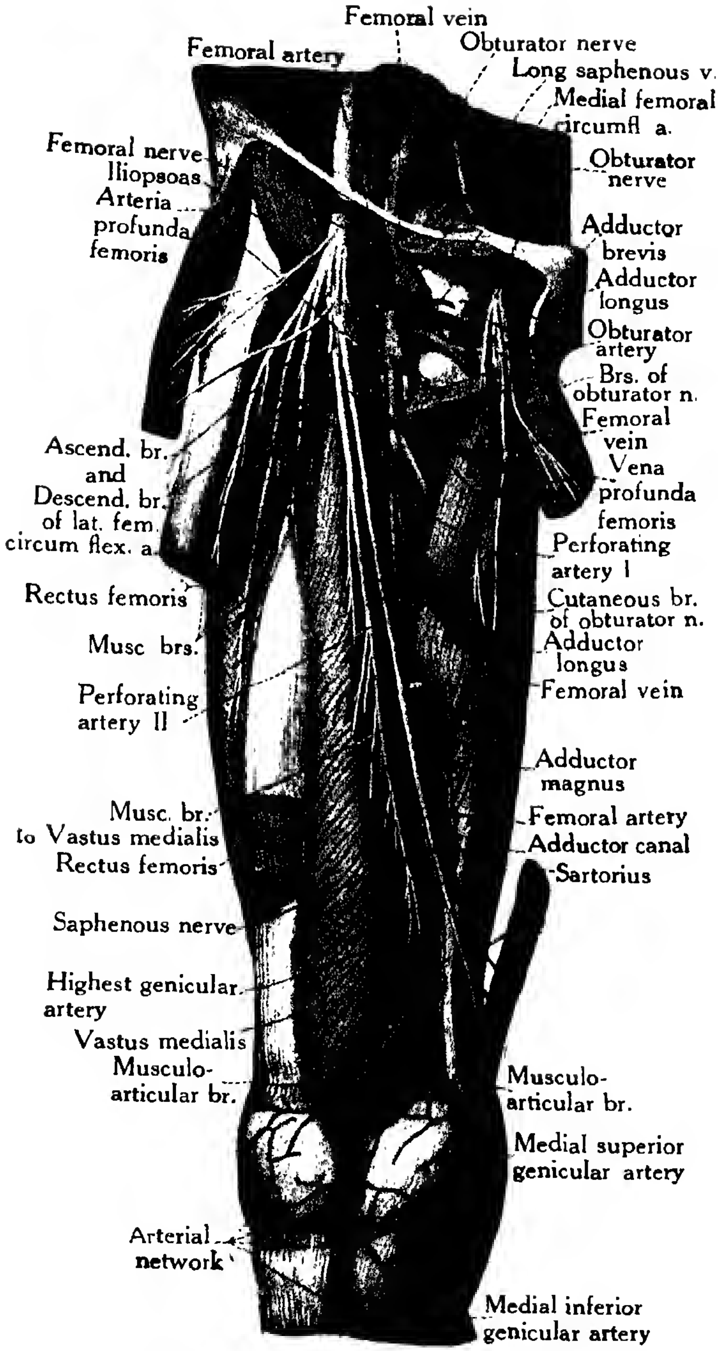


Fig. 173.—Dissection of the front of the thigh The deeper structures have been displayed (Sobotta).

the anterior aspect of the femur. On separating the margins of the incision the articularis genus is exposed as also the nerve filament which descends along the medial border of the vastus intermedius and terminates in the articularis genus and the articular capsule of the knee joint.

The **Articularis Genus** (subcrureus) arises by fleshy slips from the anterior surface of the femur about three inches above its patellar surface. It is inserted into the upper part of the articular capsule of the knee joint. It derives its nerve-supply from the femoral nerve.

Actions.—All parts of the quadriceps femoris extend the knee joint ; the rectus femoris can also flex the hip joint over which it passes. The articularis genus draws upwards the upper part of the articular capsule of the knee joint during extension.

Lateral Femoral Circumflex Artery (Fig. 173).—Its terminal branches may now be examined. Its origin from the arteria profunda femoris has been noticed. It passes lateralwards between the divisions of the femoral nerve and under cover of the sartorius and rectus femoris and divides into an ascending, a descending and a transverse branch. The *ascending branch* passes upwards beneath the tensor fasciæ latæ and anastomoses with the superior gluteal artery. The *descending branch* passes downwards on the vastus lateralis accompanied by the nerve to that muscle. It supplies the muscle and anastomoses with the superior lateral genicular branch of the popliteal artery on the lateral side of the knee. It also supplies twigs to the neighbouring muscles. The *transverse branch* passes transversely lateralwards between the vastus lateralis and the vastus intermedius, pierces the former muscle below the greater trochanter, where it has been seen to join the crucial anastomosis.

Vascular Anastomosis around the Knee joint.—In well injected subjects the student should trace the anastomoses of the blood vessels around the knee. The anastomotic arch formed by the musculo-articular branch of the highest genicular artery with the superior lateral genicular artery above the knee joint should be defined. The anastomosis between the terminal branches of the superior genicular arteries and their inosculations with the inferior genicular arteries of the corresponding sides should be traced. The descending branch of the lateral femoral circumflex artery has been already seen to join this anastomosis from above. A branch from the anterior tibial

artery, called the anterior tibial recurrent artery, joins the inferior genicular arteries from below.

MEDIAL SIDE OF THE THIGH

Devote one day to the dissection of this region.

The muscles on the medial side of the thigh are the adductores longus, brevis and magnus, the gracilis and pectineus. Medial to all and the longest, is the gracilis. The remaining muscles are arranged in three planes. Thus the pectineus and the adductor longus form the anterior layer ; the adductor brevis, the intermediate layer, and the adductor magnus, the posterior layer. This demarcation into three layers can be easily followed as the anterior branch of the obturator nerve and a part of the profunda artery are placed between the anterior and intermediate layers ; while the posterior branch of the obturator nerve is placed between the intermediate and posterior layers. The insertions of the iliopsoas, the obturator externus and the extrapelvic portion of the obturator artery come under the present dissection.

The **Gracilis** (Fig. 172) is a long flat ribbon-like muscle situated on the medial side of the thigh. It arises (1) from the anterior margin of the lower half of the symphysis pubis, and (2) from the anterior margin of the upper half of the pubic arch. The muscle passes along the medial side of the thigh and along the back part of the medial condyles of the femur and tibia and ends in a flattened tendon which is inserted into the upper part of the medial surface of the body of the tibia. The tendon of insertion is situated above the insertion of the semitendinosus and beneath the tendon of the sartorius with which it is partly blended. The tendon gives off an expansion to the deep fascia of the leg and is separated from the tibial collateral ligament of the knee joint by a mucous bursa. The gracilis is supplied by the anterior branch of the obturator nerve. It adducts the thigh, bends the knee and rotates the leg inwards.

The **Adductor Longus** arises by a thick stout tendon from the anterior surface of the medial portion of the superior ramus of the pubis in the angle between the symphysis and the pubic crest. It soon expands into a broad muscle and is inserted by an aponeurosis into the intermediate line of the linea aspera between the vastus medialis and adductor magnus. It is supplied by the anterior branch of the obturator nerve, It adducts the

thigh and flexes the hip joint ; it is also an external rotator of the thigh.

The **Pectineus** is a quadrilateral muscle, which arises from the pecten pubis and the triangular surface in front of it, and from the deep surface of the fascia covering it. The muscle passes downwards, lateralwards and backwards and is inserted into the line descending from the lesser trochanter to the linea aspera. It is supplied by a branch from the femoral nerve and sometimes also by the anterior branch of the obturator nerve and by the accessory obturator nerve when present. Its action is like that of the adductor longus.

Dissection. Divide the adductor longus and pectineus near their origin and reflect them downwards and lateralwards. While reflecting the pectineus the student should search for the accessory obturator nerve because if this nerve is present it will be seen to lie under cover of the pectineus . The arteria profunda femoris and the anterior branch of the obturator nerve which lie on front of the adductor brevis are now exposed.

The **Adductor Brevis** arises from the anterior surface of the medial portion of the superior ramus and from the anterior surface of the inferior ramus of the os pubis lateral to the origin of the gracilis. It passes downwards, lateralwards and backwards to be inserted into the whole of the line extending from the lesser trochanter to the linea aspera and into the upper part of the linea aspera behind the insertion of the pectineus. It is supplied by the obturator nerve Its action is like that of the adductor longus.

Insertion of the Iliopsoas.—The tendon of the psoas major receives nearly the whole of the fibres of the iliacus and is conjointly inserted into the lesser trochanter of the femur ; some of the fibres of the iliacus are inserted into the body of the bone immediately below for nearly an inch.

The **Arteria Profunda Femoris** has been traced from its origin in the femoral artery to the point where it passes under cover of the adductor longus (p. 585). The remaining part of its course is now exposed. It is now seen to lie between the adductor longus in front and the adductores brevis and magnus behind. The terminal part of the artery pierces the adductor magnus a little above the aperture in it for the femoral vessels and is sometimes called the *fourth perforating artery*. The *branches* given off from the profunda femoris are :—(1) The *lateral femoral circumflex artery* which has been already examined. (2) The

medial femoral circumflex artery. It passes backwards at first between the pectineus and the psoas major and then between the adductor brevis and the obturator externus and divides into terminal branches. It gives off (*a*) *muscular branches* to the neighbouring muscles ; (*b*) an *acetabular branch* which enters the acetabular notch beneath the transverse acetabular ligament to supply the interior of the hip joint ; (*c*) the *terminal branches*, superficial and deep. The *superficial branch* has been seen to appear in the gluteal region between the adductor magnus and the quadratus femoris and join the crucial anastomosis. The *deep branch* has been traced to the trochanteric fossa along the tendon of the obturator externus. (3) Three *perforating arteries*—they pierce the aponeurotic insertion of the adductor magnus close to the linea aspera and reach the back of the thigh. The *first perforating artery* issues near the lower border of the pectineus and passes backwards piercing the adductor brevis and adductor magnus. The *second perforating artery* issues below the first or in common with it and proceeds backwards piercing the same muscles ; the *nutrient artery* of the femur is usually derived from it. The *third perforating artery* issues below the adductor brevis and pierces the adductor magnus only. The anastomoses of the perforating arteries with each other have been examined at the back of the thigh. (4) The *muscular branches* supply the adductor muscles between which the parent trunk passes.

Obturator Nerve.—Its origin from the lumbar plexus and course in the pelvis have been described (p. 100). It emerges from the pelvis through the upper the part of the obturator foramen along with the obturator vessels and within the foramen it divides into an anterior and a posterior branch. The *anterior branch* passes downwards upon the anterior surface of the adductor brevis and lies under cover of the pectineus and adductor longus. It then descends upon the femoral artery and finally breaks up into minute twigs over its walls. It supplies (1) an articular twig to the hip joint ; (2) branches to the gracilis, adductor longus and adductor brevis and occasionally to the pectineus; (3) a twig which issues at the lower border of the adductor longus and joins the subsartorial plexus. Occasionally this twig not only sends a filament to the subsartorial plexus but is continued downwards as a cutaneous branch along the posterior border of the sartorius to the medial side of the upper third of the leg. The anterior branch of the obturator nerve is joined by a filament from the accessory obturator nerve, when that nerve is present.

Dissection. Divide the adductor brevis close to its origin and reflect it downwards and lateralwards. The posterior branch of the obturator nerve is exposed which should be fully dissected out.

The *posterior branch of the obturator nerve* passes through the obturator externus and supplies it. It then descends behind the adductor brevis and in front of the adductor magnus and is exhausted while supplying branches to the latter muscle. It gives an *articular branch* which pierces the adductor magnus above the opening for the femoral vessels and accompanies the popliteal artery to the knee joint (p. 568).

Accessory Obturator Nerve.—Its origin from the lumbar plexus has been described (p 100). It leaves the pelvis under cover of the pectineus, supplies a twig to the hip joint and ends by joining the anterior branch of the obturator nerve. Occasionally it supplies a twig to the pectineus.

The **Adductor Magnus** is triangular in shape with its base directed upwards ; its lateral side is attached to the femur ; its medial side is free. It arises (1) from the anterior surface of the inferior rami of the os pubis and ischium ; and (2) from the lateral margin of the inferior triangular portion of the tuberosity of the ischium. The fibres which arise from the inferior ramus of the os pubis are horizontal in direction and are inserted into a line medial to the gluteal tuberosity of the femur. The fibres which arise from the tuberosity of the ischium are almost vertical in direction and end in a tendon which is inserted into the adductor tubercle and to the medial intermuscular septum. The fibres which arise from the inferior ramus of the ischium, pass obliquely downwards and lateralwards and are inserted by an aponeurosis into the intermediate line of the linea aspera and into the upper part of its medial prolongation below. Close to its insertion into the linea aspera are seen a series of tendinous arches which transmit the three perforating arteries, the terminal part of the arteria profunda femoris and the femoral vessels. The lowest opening is the largest and is for the last named vessels. The muscle is supplied by the sciatic nerve and by the posterior branch of the obturator nerve. It acts like the other adductor muscles.

Dissection. Divide the adductor magnus at its origin and reflect it lateralwards. The obturator externus is now fully exposed.

The **Obturator Externus** is a fan-shaped muscle which arises

by its broad base (1) from the anterior surface of the rami of the os pubis and the inferior ramus of the ischium close to the medial margin of the obturator foramen ; and (2) from the medial two-thirds of the outer surface of the obturator membrane. The fibres pass backwards and lateralwards and converge to a tendon which ascends along the back part of the neck of the femur to be inserted into the trochanteric fossa. It is supplied by the posterior branch of the obturator nerve which passes through its substance. It flexes the hip joint and rotates the thigh lateralwards.

Dissection. Detach the obturator externus from its origin. The obturator vessels which lie under cover of the muscle are exposed.

Obturator Artery.—Its origin and course through the pelvis have been described (p. 111). It issues out of the pelvis through the obturator canal accompanied by the obturator nerve and divides into an anterior and a posterior branch. The *anterior branch* runs forwards and then downwards along the medial margin of the obturator foramen and anastomoses with the posterior branch. The *posterior branch* runs downwards along the lateral margin of the obturator foramen and then curves upwards to anastomose with the anterior branch ; this anastomosis completes an arterial circle upon the obturator membrane along the circumference of the obturator foramen. *Muscular branches* are given off from both the branches to the adductor muscles and the obturator externus. An *articular twig* is given off from the posterior branch which enters the hip joint through the acetabular notch.

COXAL ARTICULATION OR HIP JOINT

The hip joint is a typical ball-and-socket joint formed by the reception of the head of the femur into the acetabular cavity. The ligaments belonging to this joint are :—(1) the articular capsule, (2) the glenoidal labrum, (3) the transverse acetabular ligament ; and (4) the ligamentum teres femoris.

Dissection. The student should first expose and clean the articular capsule of the hip joint. Divide the femoral vessels and nerve about an inch (2.5 cm.) below the inguinal ligament. Divide the sartorius and the rectus femoris two inches below their origin. Detach the iliopsoas from its insertion into the lesser trochanter and raise it from the anterior aspect of the

articular capsule. Note that a mucous bursa is interposed between the iliopsoas and the articular capsule.

The **Articular Capsule** is very strong and is not loose like that of the shoulder joint. In the hip bone it is attached in front to the outer surface of the glenoidal labrum ; above and behind to the rim of the acetabulum beyond the glenoidal labrum ; and below to the transverse acetabular ligament. In the femur it is attached in front to the intertrochanteric line ; above, to the base of the neck ; behind, to the posterior surface of the neck half an inch above the intertrochanteric crest ; and below, to the lower part of the neck. From this line of attachment to the femur some of the deep fibres of the articular capsule are prolonged upwards on to the neck of the femur and are thrown into longitudinal ridges. This reflection is called the *retinacula*. The articular capsule is thick at the upper and front aspect of the joint where the fibres composing it are directed longitudinally from one bone to the other. It is thin at the lower and back part where the fibres are disposed circularly forming what is called the *zona orbicularis*. The mucous bursa lying between the front part of the articular capsule and the iliopsoas has been already noted ; sometimes it communicates with the synovial stratum of the capsule. The blending of the capsule with the tendon of the glutæus minimus has also been noted.

Certain accessory bands of the articular capsule should now be examined. These are :—

(1) The *iliofemoral ligament* (Y-shaped ligament of Bigelow) is the thickest and strongest band of the capsule. Its shape is in reality like that of an inverted **Y** and it is attached to the anterior inferior spine of the ilium by the stem of the **Y**. Below, the two limbs diverge ; the lateral limb, called the *iliotrochanteric ligament*, is fixed to the upper end of the intertrochanteric line ; the medial limb is attached to the lower end of the same line. The intervening portion of the capsule between the two limbs is thin.

(2) The *pubocapsular ligament* (pubofemoral ligament) is attached above to the iliopectineal eminence and the obturator membrane. Below it blends with the lower and front part of the capsule under cover of the medial band of the iliofemoral ligament.

(3) The *ischiocapsular ligament* arises from the ischium below the acetabulum and the fibres pass upwards and lateralwards along the back part of the capsule with which they are blended.

Dissection. The joint should now be opened by a circular cut along the middle of the capsule.

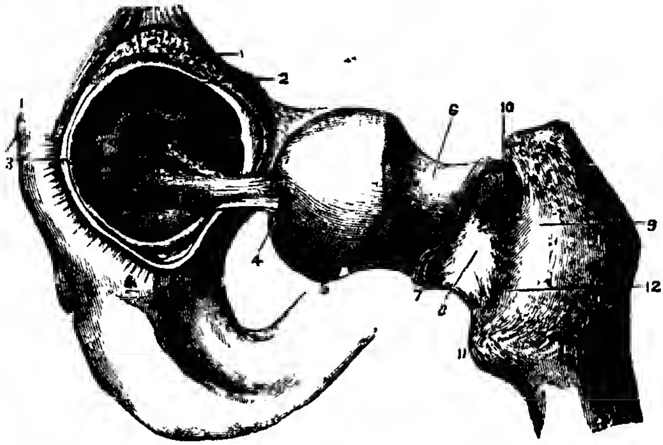


Fig. 174.—Ligaments of the hip joint (Sappey).

1. Ilio-femoral ligament (cut).
2. Glenoidal labrum.
3. Ligamentum teres femoris.
4. Attachment of the same into the head of the femur.
5. Head of the femur.
6. Neck of the femur.
7. Attachment of articular capsule.
8. Neck of femur (extracapsular part).
9. Greater trochanter.
10. Trochanteric fossa.
11. Lesser trochanter.
12. Intertrochanteric crest.

The **Synovial stratum** lines the inner surface of the fibrous capsule and is reflected on both surfaces of the glenoidal labrum. Then it lines the acetabular cavity and the mass of fat lying at its bottom, ensheaths the ligamentum teres femoris and is reflected on the head and on the retinacula covering the intracapsular portion of the neck of the femur.

The **glenoidal labrum** (cotyloid ligament) is a circular fibrocartilaginous band which deepens the acetabular cavity. It is attached to the margin of the acetabulum and to the transverse acetabular ligament which bridges over the acetabular notch. Its attached margin is thicker than the free margin which serves to narrow the mouth of the acetabulum. Its surfaces are lined by the synovial stratum.

The **transverse acetabular ligament** bridges over the acetabular notch and is attached to its margins. Laterally it gives attachment to the glenoidal labrum and medially bounds the acetabular notch converting it into a foramen for the passage of articular vessels and nerves to the joint.

The **ligamentum teres femoris** is a triangular band attached by its apex to the upper part of the fovea capitis femoris. The base of the ligament is expanded and consists of two thickened bands and an intermediate thin portion. The thickened bands are fixed to the margins of the acetabular notch and the intermediate thin portion is attached to the transverse acetabular ligament. The ligament is invested by the synovial stratum.

A mass of fat (Haversian gland) occupies the rough depression at the bottom of the acetabulum. It is covered by the synovial stratum and the ligamentum teres rests against it.

The *arteries* which enter the hip joint through the acetabular notch are the articular twigs derived from the medial femoral circumflex artery and posterior branch of the obturator artery. The *nerves* which enter the joint through the same notch are the articular twigs derived from the anterior branch of the obturator and accessory obturator nerves.

Movements.—The hip joint permits of the same kinds of movement as the shoulder joint but all of them are of a more limited extent. The strong iliofemoral ligament stops any attempt to carry the femur beyond a straight line with the trunk and maintains the erect position of the body without muscular exertion.

The *flexors* of the hip joint are: the iliacus, psoas major, pectineus, rectus femoris and adductors. The *extensors* are: glutæus maximus, biceps femoris, semimembranosus and semitendinosus. The *abductors* are: glutæus medius, glutæus minimus, tensor fasciæ latæ and sartorius. The *adductors* are: adductores longus, brevis and magnus, gracilis and pectineus. The *medial rotators* are: tensor fasciæ latæ, glutæus medius and glutæus minimus. The *lateral rotators* are: the sartorius, quadratus femoris, piriformis, obturatores, gemelli and adductores.

Directions. The limb should now be removed from the body by dividing the ligamentum teres. The muscles should not be removed from the femur but about two inches of each should be left attached to the femur for future examination.

THE ANTERIOR REGION OF THE LEG AND DORSUM OF THE FOOT

Surface Anatomy.—The student should feel for himself the bony landmarks before the skin is reflected :—The anterior crest of the tibia or the shin ; the medial margin and medial

surface of the body of the tibia ; the lower fourth of the body of the fibula ; and the two malleoli. The tip of the medial malleolus lies on a higher level than that of the lateral malleolus. Along the lateral margin of the foot can be felt the subcutaneous lateral surface of the calcaneus ; the cuboid in front of it ; and the tuberosity at the base of the fifth metatarsal bone. Along the medial margin of the foot should be felt and identified the medial process of the calcaneal tuberosity ; the medial margin of the sustentaculum tali ; the tuberosity of the navicular bone ; the medial surface of the first cuneiform bone ; and the first metatarsal bone.

Directions. The limb should be placed at a convenient height by putting a block beneath the knee. The foot should be extended in order that the muscles on the dorsum of the foot are put on stretch, and fixed in this position by hooks.

Dissection. The following *incisions* (Fig. 4) are to be made : (1) a vertical incision along the middle line of the front of the leg and ankle and along the middle line of the dorsum of the foot up to the cleft between the second and third toes ; (2) a transverse incision across the front of the ankle joint ; (3) a curved incision across the dorsum of the foot along the roots of the toes. Four flaps of skin are thus obtained : the upper medial flap is to be reflected medially to the full extent so that the medial region of the leg is fully exposed ; the upper lateral flap should be similarly reflected so that the lateral region of the leg is fully exposed ; the two lower flaps are to be reflected to their respective sides so that a complete view of the dorsum of the foot is obtained. The skin from the dorsal aspect of each toe is to be reflected by making a median longitudinal incision along the dorsum of each toe.

The **Superficial Fascia** of the front of the leg and the dorsum of the foot contains a limited amount of fat and in it are contained the various superficial veins and cutaneous nerves. These are to be dissected out in the order they are described below.

Superficial Veins.—Two *dorsal digital veins* run along the dorsum of each toe ; one is placed along the medial side of the dorsum of the toe and the other on its lateral side. On reaching the clefts between the toes they receive *intercapitular veins* from the plantar digital veins. The two dorsal digital veins which run along the two contiguous sides of adjacent toes unite at the clefts between them to form a trunk ; in this way four trunks, called the *dorsal metatarsal veins*, are formed which terminate in

the dorsal venous arch. The medial dorsal digital vein (medial marginal vein) of the great toe opens into the medial end of the dorsal venous arch while the lateral dorsal digital vein of the little toe (lateral marginal vein) terminates in the lateral end of the arch The *dorsal venous arch* extends across the distal end of the metatarsal bones. This venous arch receives along its convexity the four dorsal metatarsal veins. A network of veins is situated in the concavity of the arch and communicates with it. The *great saphenous vein* begins at the junction of the medial end of the dorsal venous arch with the medial dorsal digital vein of the great toe. It ascends in front of the medial malleolus and along the medial side of the leg and is accompanied by the saphenous nerve in the leg and foot. Its course along the thigh and its termination in the femoral vein have been examined (p. 578). The *small saphenous vein* begins at the junction of the lateral end of the dorsal venous arch with the lateral dorsal digital vein of the little toe. It ascends behind the lateral malleolus into the back part of the leg, where it will be traced subsequently. It is accompanied by the sural nerve.

Cutaneous Nerves (Fig. 170).—(1) The *saphenous nerve* descends along the medial side of the leg by the side of the great saphenous vein and terminates at the medial side of the dorsum of the foot. Sometimes it can be traced as far as the ball of the great toe. It communicates with the medial branch of the superficial peroneal nerve. (2) The *sural nerve* follows the course of the small saphenous vein and runs below the lateral malleolus. It then receives the name of the *lateral dorsal cutaneous nerve* of the foot and proceeds along the lateral side of the dorsum of the foot and the little toe. It communicates medially with the intermediate dorsal cutaneous nerve. (3) The *superficial peroneal nerve* pierces the deep fascia at the junction of the middle and lower thirds of the leg and close to the medial side of the fibula ; it divides into medial and intermediate dorsal cutaneous nerves. The *medial dorsal cutaneous nerve* divides into two dorsal digital branches. One of these passes to the medial side of the dorsum of the foot, supplies the skin over the part and communicates with the saphenous nerve. It is continued along the medial side of the great toe and also communicates with the terminal part of the deep peroneal nerve at the cleft between the first and second toes. The other dorsal digital branch passes towards the cleft between the second and third toes and divides into two branches which supply the contiguous

sides of these toes. The *intermediate dorsal cutaneous nerve* passes along the lateral side of the dorsum of the foot and divides into two dorsal digital branches ; one of which bifurcates to supply the contiguous sides of the third and fourth toes while the other bifurcates to supply the contiguous sides of the fourth and fifth toes. It communicates laterally with the lateral dorsal cutaneous nerve. (4) The *medial terminal branch of the deep peroneal nerve* pierces the deep fascia over the first interosseous space, communicates with the medial dorsal cutaneous nerve and bifurcates to supply the contiguous sides of the great and second toes. (5) The *lateral sural cutaneous nerve* has been seen to arise from the common peroneal nerve. It supplies the skin on the anterolateral aspect of the upper part of the leg.

Dissection. Remove the fatty superficial fascia and clean the surface of the deep fascia.

The **Fascia Cruris** or **Deep Fascia** of the leg does not form, like the fascia lata of the thigh, a complete covering of the leg. It is absent over the medial surface of the tibia and over the head and malleolus of the fibula—in which situations it is blended with the periosteum. It is thick and strong at the upper part of the front of the leg where it gives origin to the muscles of that region from its deep surface. It becomes thinner as it passes to the lower part of the leg and reaching the ankle becomes thick again. It is attached around the knee to the patella, the tuberosity and condyles of the tibia and head of the fibula ; and in front of the leg to the anterior and medial borders of the tibia. It gives off intermuscular septa from its deep surface which will be examined during the reflection of the fascia. Five thickened fibrous bands are seen in the deep fascia around the ankle. They keep the tendons in situ in their passage to the foot. These bands may now be examined in detail.

(1) The *transverse crural ligament* (upper part of the anterior annular ligament) is a broad thickened band which lies in front of the lower part of the leg and stretches between the lower ends of the anterior border of the tibia and of the anterolateral border of the fibula. It retains the tendons of the tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius in situ.

(2) The *cruciate crural ligament* (lower part of the anterior ligament) is placed in front of the ankle and is continuous below with the deep fascia on the dorsum of the foot. It presents the appearance of **Y** the stem of which is directed laterally, overlies

the tendon of the extensor digitorum longus and peronæus tertius and is attached to the anterior part of the upper surface of the calcaneus. Of the two diverging limbs of the **Y** the proximal one passes upwards and medialwards to be attached to the anterior margin of the medial malleolus over the tendon of the extensor hallucis longus but splits to enclose the tendon of the tibialis anterior in its course. The distal limb passes downwards and medialwards over the tendons of the extensor hallucis longus and tibialis anterior and is blended with the plantar aponeurosis at the medial margin of the foot. Further examination of the cruciate ligament will reveal that it forms three separate compartments as it stretches in front of the ankle and that the lateral compartment contains the extensor digitorum longus and peronæus tertius; the middle compartment gives passage to the extensor hallucis longus; and the medial compartment transmits the tibialis anterior.

(3) The *laciniate ligament* will be studied later on.

(4, 5) The *peroneal retinacula* are two in number, superior and inferior. They bind the tendons of the peronæi longus and brevis in position. The *superior peroneal retinaculum* (external annular ligament) extends from the posterior border of the lateral malleolus to the back part of the lateral surface of the calcaneus. The *inferior peroneal retinaculum* is attached at one end to the anterior part of the upper surface of the calcaneus where it is continuous with the stem of the cruciate crural ligament. Its other extremity is fixed to the trochlear process and anterior part of the lateral surface of the calcaneus.

Deep fascia and mucous sheaths on the dorsum of the foot.—The deep fascia on the dorsum of the foot is thin, membranous and is continuous with the plantar aponeurosis on either side. The mucous sheaths found on the dorsum of the foot are: (1) the sheath of the tibialis anterior which extends from the upper border of the transverse crural ligament to the proximal part of the navicular bone. (2) The sheath of the extensor hallucis longus extends from the lower margin of the transverse crural ligament to the base of the first metatarsal bone. (3) The sheath of the extensor digitorum longus and peronæus tertius extends from the lower margin of the transverse crural ligament to the level of the base of the fifth metatarsal bone. The limits of these sheaths can be verified either by injecting coloured fluid or by passing a probe into each of them near the transverse crural ligament.

Dissection. The deep fascia on the front of the leg is now to be removed. Keep the transverse and cruciate crural ligaments intact so that the tendons are retained in position. Make a vertical incision in the deep fascia between the two bones of the leg and reflect the two portions on either side. While reflecting the deep fascia note that the muscles on the front of the leg take their origin from its deep surface at the upper part of the leg. Observe that a strong intermuscular septum, called the *anterior fibular intermuscular septum*, extends from the deep surface of the fascia to the anterolateral border of the fibula and separates the muscles on the front of the leg from the peronæi longus and brevis. Remove the deep fascia from the dorsum of the foot. Five muscles, viz. the tibialis anterior, extensor digitorum longus, extensor hallucis longus, peronæus tertius, and extensor digitorum brevis are now exposed; these should be cleaned and studied.

The **Tibialis Anterior** (Tibialis anticus) is thick and fleshy in the upper part, but tendinous in the lower part of the leg. It arises (1) from the lateral condyle of the tibia and from the upper half of the lateral surface of its body; (2) from the anterior surface of the interosseous membrane; (3) from the deep fascia of the leg; and (4) from the intermuscular septum between it and the extensor digitorum longus. The muscle ends in a stout tendon which passes beneath the transverse and cruciate crural ligaments and is inserted into the medial and inferior surfaces of the first cuneiform bone and into the medial side of the base of the first metatarsal bone. It is supplied by the deep peroneal nerve. It flexes the ankle joint and inverts the foot.

The **Extensor Digitorum Longus** arises (1) from the lateral condyle of the tibia; (2) from the head and upper three-fourths of the anterior surface of the body of the fibula; (3) from the upper part of the interosseous membrane; (4) from the intermuscular septum between it and the tibialis anterior; (5) from the anterior fibular intermuscular septum; and (6) from the deep fascia of the leg. The muscle ends in a tendon which passes beneath the transverse and cruciate crural ligaments to the dorsum of the foot and divides into four slips for the lateral four toes. On the dorsal aspect of the first phalanx each slip widens into an expansion and receives the insertions of the corresponding lumbrical and interosseous muscles. Opposite the metatarsophalangeal articulations the tendons for the second, third, and fourth toes are each joined laterally by a tendon

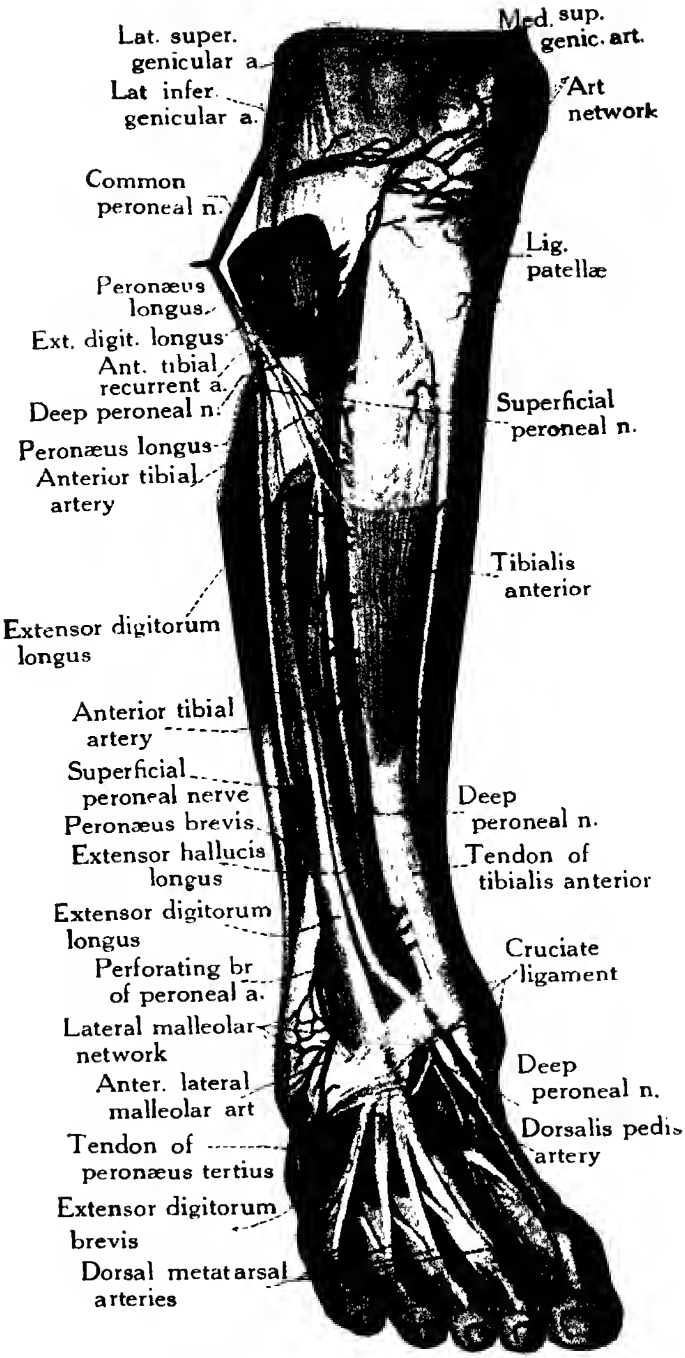


Fig. 175.---Dissection of the anterior and lateral regions of the leg and the dorsum of the foot (Sobotta).

To face P. 606

of the extensor digitorum brevis. The mode of insertion of the expansion of the extensor tendon is the same as that of the corresponding tendon of the finger. Thus opposite the first interphalangeal articulation the expansion splits into an intermediate and two collateral slips. The intermediate slip is attached to the dorsum of the base of the second phalanx. The two collateral slips reunite on the dorsum of the second phalanx to be inserted into the dorsum of the base of the third phalanx. The muscle is supplied by the deep peroneal nerve. It extends the phalanges of the toes and also flexes the ankle joint.

The **Extensor Hallucis Longus** is placed between the tibialis anterior and the extensor digitorum longus. It arises from the middle two-fourths of the anterior surface of the fibula medial to the origin of the extensor digitorum longus and from the interosseous membrane. The muscle ends in a tendon which passes beneath the transverse and cruciate crural ligaments. It crosses to the medial side of the foot to gain the dorsal aspect of the great toe. The tendon usually gives off a slip to the base of the first phalanx and is finally inserted into the dorsum of the base of the last phalanx. It is supplied by the deep peroneal nerve. It extends the phalanges of the great toe and also flexes the ankle joint.

The **Peronæus Tertius** is united at its origin with the extensor digitorum longus. It arises (1) from the lower fourth of the anterior surface of the fibula below the origin of the extensor digitorum longus; (2) from the interosseous membrane; and (3) from the corresponding part of the anterior fibular intermuscular septum. Its tendon passes behind the transverse and cruciate crural ligaments with that of the extensor digitorum longus and is inserted into the dorsum of the base of the fifth metatarsal bone. It is supplied by the deep peroneal nerve. It everts the foot and flexes the ankle joint.

The **Extensor Digitorum Brevis** arises (1) from the front part of the upper surface and the adjoining lateral surface of the calcaneus; (2) from the stem of the cruciate crural ligament; and (3) from the lateral talocalcaneal ligament. The muscle divides into four tendons which pass forwards and medialwards to the medial four toes. The most medial part of the muscle is a separate portion and is called the *extensor hallucis brevis*; it ends in a tendon which crosses the terminal part of the dorsalis pedis artery and becomes inserted into the dorsum of the base of the first phalanx of the great toe. The tendons for the second,

third and fourth toes are blended with the corresponding tendons of the extensor digitorum longus on their lateral sides. The muscle is supplied by the lateral terminal branch of the deep peroneal nerve. It extends the phalanges of the toes to which it is inserted.

Dissection. Divide the intermuscular septum along its entire length between the tibialis anterior and the extensor digitorum longus. Separate the extensores digitorum longus and hallucis longus from the tibialis anterior and keep them apart by hooks. The anterior tibial vessels and the deep peroneal nerve are now fully exposed. The anterior tibial artery and its branches are to be dissected out. The first branch given off from the artery as soon as it appears in front of the leg is the anterior tibial recurrent artery which ascends through the fibres of the tibialis anterior. Its muscular branches to the muscles on either side are to be cleaned. Its anterior medial malleolar and anterior lateral malleolar branches are given off proximal to the ankle joint. The continuation of the anterior tibial artery, viz., the dorsalis pedis artery and its branches should be traced on the dorsum of the foot. The lateral tarsal and arcuate arteries will be seen issuing from the lateral side of the artery and the medial tarsal artery, from the medial side. The terminal branches viz., the first dorsal metatarsal artery and the deep plantar artery, will be seen in the proximal part of the first intermetatarsal space The perforating branch of the peroneal artery is to be displayed as it appears in front of the leg about two inches above the lateral malleolus by drawing aside the tendons of the extensor digitorum longus and the peronæus tertius. Next the deep peroneal nerve is to be traced to its termination on the dorsum of the foot into medial and lateral branches. Its branches to the neighbouring muscles in front of the leg are to be exhibited.

The **Anterior Tibial Artery** is one of the terminal branches of the popliteal artery and begins at the lower border of the popliteus. It gains the front aspect of the leg by passing through an aperture in the upper part of the interosseous membrane. It then descends in front of the interosseous membrane lying at first between the tibialis anterior medially and the extensor digitorum longus laterally. Thereafter it lies between the tibialis anterior medially and the extensor hallucis longus laterally. In the lower third of the leg it lies in front of the lower end of the tibia and in front of the ankle is overlapped by the tendon of the extensor hallucis longus which crosses it and lies on its medial

side. Finally the artery is continued on the dorsum of the foot as the dorsalis pedis artery. The deep peroneal nerve lies on the lateral side of the artery in the upper third of the leg; in front of the artery in the middle third; and again on its lateral side in the lower third. Two venæ comitantes accompany the artery. The *branches* given off from the artery in front of the leg are:—(1) The *anterior tibial recurrent artery* which arises from the parent trunk as soon as it reaches the front of the leg. It ascends through the fibres of the tibialis anterior and anastomoses with the inferior genicular branches of the popliteal artery. (2) The *muscular branches* are given off from either side of the artery and supply the muscles in front of the leg. (3) The *anterior medial malleolar artery* (internal malleolar artery) arises from the parent trunk in front of the lower end of the tibia. It passes medialwards behind the tendon of the tibialis anterior and anastomoses on the medial malleolus with the posterior medial malleolar branch of the posterior tibial artery and the medial tarsal branches of the dorsalis pedis. (4) The *anterior lateral malleolar artery* (external malleolar artery) arises a little below the preceding artery. It passes lateralwards behind the tendons of the extensor digitorum longus and the peronæus tertius to the lateral aspect of the lateral malleolus and anastomoses with the perforating branch of the peroneal artery and with the lateral tarsal artery.

Anterior tibial lymph gland.—This small lymph gland is sometimes found on the interosseous membrane close to the upper end of the anterior tibial artery. Its efferents open into the popliteal lymph glands.

The **Dorsalis Pedis Artery** is the continuation of the anterior tibial artery on the dorsum of the foot. It commences at a point midway between the two malleoli in front of the ankle joint and passes forwards to the proximal part of the first intermetatarsal space where it divides into two terminal branches, viz., the first dorsal metatarsal and deep plantar arteries. On its medial side is the tendon of the extensor hallucis longus; on its lateral side are the most medial tendon of the extensor digitorum longus and the terminal part of the deep peroneal nerve. It rests upon the articular capsule of the ankle joint, the talus, navicular and second cuneiform bones. It is crossed from the lateral to the medial side by the most medial tendon of the extensor digitorum brevis. Two venæ comitantes accompany it.

Branches.—(1) The *lateral tarsal artery* arises when the parent trunk lies over the navicular bone. It passes lateralwards under cover of the extensor digitorum brevis and anastomoses with the lateral plantar artery laterally, with the arcuate artery in front and with the anterior lateral malleolar and terminal part of the peroneal artery above. (2) The *medial tarsal arteries* are two or three twigs which pass towards the medial border of the foot and anastomose with the anterior medial malleolar artery. (3) The *arcuate artery* (metatarsal artery) passes lateralwards across the bases of the metatarsal bones under cover of the tendons of the extensor digitorum brevis and anastomoses with the lateral plantar and lateral tarsal arteries. At the proximal parts of the second, third, and fourth interosseous spaces it gives off the second, third, and fourth *dorsal metatarsal arteries* respectively. These pass along the corresponding interosseous spaces and opposite the clefts between the toes each bifurcates into two *dorsal digital arteries* to supply the contiguous sides of the adjoining toes. The fourth dorsal interosseous artery gives off a branch which supplies the lateral side of the little toe. Soon after their origin the dorsal metatarsal arteries are joined by the posterior perforating branches of the plantar arch and near the heads of the metatarsal bones, they are joined by the anterior perforating branches of the plantar metatarsal arteries. (4) The *first dorsal metatarsal artery* (arteria dorsalis hallucis) passes forwards on the first interosseous space and, like the other dorsal metatarsal arteries, bifurcates to supply the contiguous sides of the great and second toes. It gives off a branch which supplies the medial side of the great toe. (5) The *deep plantar artery* is the continuation of the dorsalis pedis artery. It dips between the two heads of origin of the first dorsal interosseous muscle at the proximal part of the first intermetatarsal space and completes the plantar arch by joining the lateral plantar artery at the sole of the foot.

The *perforating branch of the peroneal artery* (anterior peroneal artery) appears in front of the lower part of the leg by piercing the interosseous membrane about two inches above the lower end of the lateral malleolus. It passes laterally and descends behind the peronæus tertius to the lateral side of the tarsus anastomosing with the anterior lateral malleolar and lateral tarsal arteries.

The **Deep Peroneal Nerve** (anterior tibial nerve) begins as one of the terminal branches of the common peroneal nerve,

between the neck of the fibula and the upper part of the peronæus longus. It passes forwards, pierces the extensor digitorum longus and gains the front of the interosseous membrane. It descends over the membrane and lies on the lateral side of the anterior tibial artery at the upper third of the leg. Opposite the middle third of the leg the nerve overlaps the artery and near the ankle again lies to its lateral side. Then it passes behind the transverse crural and cruciate crural ligaments and, reaching the dorsum of the foot, divides into a medial and a lateral terminal branch. In the leg it gives muscular branches to the tibialis anterior, extensor digitorum longus, peronæus tertius, and extensor hallucis longus. In front of the ankle it gives off an *articular twig* to the joint. The *medial terminal branch* proceeds forwards on the lateral side of the dorsalis pedis artery. Reaching the first intermetatarsal space it gives off an interosseous branch which supplies the first dorsal interosseous muscle. It then divides into two dorsal digital nerves which supply the contiguous sides of the great and second toes. The *lateral terminal branch* passes lateralwards beneath the extensor digitorum brevis and presents an enlargement on it like that seen on the dorsal interosseous nerve at the wrist. It supplies the extensor digitorum brevis. Three interosseous branches corresponding to the three lateral interosseous spaces take their origin from the ganglionic enlargement and supply the neighbouring joints. The twig for the second interosseous space sometimes supplies the second dorsal interosseous muscle.

MEDIAL REGION OF THE LEG

In this region the student has to examine the following structures:—(1) The *great saphenous vein* which ascends along the medial side of the leg. (2) The *saphenous nerve* descends in company with the vein. (3, 4, 5) The *insertions of the tendons of the sartorius, gracilis* and *semitendinosus* into the upper part of the medial surface of the body of the tibia. Note that the tendon of insertion of the sartorius expands into a broad aponeurosis and embraces the insertion of the gracilis and the upper part of the insertion of the semitendinosus. (6) *Mucous bursæ* exist between the tendons of insertion and thus separate them from each other. (7) The *tibial collateral ligament* is seen beneath the insertions of the three muscles.

LATERAL REGION OF THE LEG

Dissection. Divide the anterior fibular intermuscular septum and note the *posterior fibular intermuscular septum* passing from the deep fascia to the posterolateral border of the fibula. Remove the deep fascia covering the peronæi longus and brevis.

The **Peronæus Longus** is situated on the lateral side of the leg. It arises (1) from the head and upper two thirds of the lateral surface of the body of the fibula ; (2) from the anterior and posterior fibular intermuscular septa ; and (3) from the deep fascia covering it. The muscle ends in a tendon which passes with the tendon of the peronæus brevis along the groove behind the lateral malleolus to the lateral surface of the calcaneus being retained in position by the superior and inferior peroneal retinacula. On the lateral surface of the calcaneus it lies below the peronæus brevis from which it is separated by the trochlear process. The tendon turns round the lateral surface of the cuboid to gain the sole of the foot where it will be subsequently traced to its insertion into the first cuneiform and the base of the first metatarsal bone. The tendon is enclosed by a mucous sheath behind and below the lateral malleolus containing also the tendon of the peronæus brevis. But below the trochlear process on the lateral surface of the calcanæus it is enclosed in a separate mucous sheath which extends proximally to the lateral surface of the cuboid or is continuous with the mucous sheath enclosing the same tendon in the sole of the foot up to its insertion into the base of the first matatarsal bone. Sometimes the mucous sheath is interrupted on the lateral surface of the cuboid. The muscle is supplied by the superficial peroneal nerve. It extends the ankle joint and causes eversion of the foot.

The **Peronæus Brevis** arises (1) from the lower two-thirds of the lateral surface of the body of the fibula, (the upper part of this origin is attached anterior to the origin of the peronæus longus) ; and (2) from the anterior and posterior fibular intermuscular septa. Its tendon passes behind the lateral malleolus lying in front of that of the peronæus longus and enclosed in the same mucous sheath with it. On the lateral surface of the calcaneus it lies above the trochlear process and has a separate mucous sheath. It is inserted into the lateral aspect of the tuberosity at the base of the fifth metatarsal bone. The muscle

is supplied by the superficial peroneal nerve. It extends the ankle joint and also causes eversion of the foot.

The **Common Peroneal Nerve** has been traced to the neck of the fibula. Its terminal part lies on the lateral side of the neck of the fibula under cover of the origin of the peronæus longus. It then divides into the superficial and deep peroneal nerves beneath that muscle. Before its division it gives off a *recurrent articular twig* which ascends with the anterior tibial recurrent artery to supply the knee joint.

The **Superficial Peroneal Nerve** (musculocutaneous nerve) descends through the fibres of the peronæus longus to the interval between it and the peronæus brevis and supplies both the muscles It then lies between the peronæus brevis and extensor digitorum longus and becomes cutaneous by piercing the deep fascia at the lower third of the leg. Its further course and distribution on the dorsum of the foot have been examined (p. 603).

POSTERIOR REGION OF THE LEG

Directions. Place the limb with its posterior surface uppermost. Flex the ankle over the edge of the table and fix the foot with hooks in order that the muscles of the calf may be put on stretch.

Dissection. The following *incisions* should be made:—(1) A longitudinal incision along the middle line of the back of the leg up to end of the heel ; (2) a transverse incision at the lower end of the vertical incision along the margins of the foot terminating opposite the lower ends of the malleoli. Reflect the flaps of skin on either side (Fig. 71).

The *superficial fascia* of this region is fatty and contains the superficial veins and cutaneous nerves which are to be dissected out in the order described below.

Superficial Veins.—These are : (1) The *small saphenous vein* which ascends behind the lateral malleolus after its origin from the union of the lateral dorsal digital vein of the little toe with the lateral end of the dorsal venous arch (p. 603). It then ascends in company with the sural nerve along the lateral margin of the tendocalcaneus and crossing the tendon reaches the middle line of the back of the leg. Thereafter it ascends along the middle line between the two heads of the gastrocnemius and pierces the deep fascia over the lower part of the popliteal fossa to terminate in the popliteal vein. In the lower part of its course

along the middle line it is accompanied by the medial sural cutaneous nerve ; and in the upper part, by the posterior femoral cutaneous nerve. (2) The *great saphenous vein* (p. 603) ascends in front of the medial malleolus and then along the medial surface of the lower third of the tibia ; it next ascends along the medial border of the tibia to the posterior aspect of the medial surface of the knee and finally running along the anteromedial side of the thigh terminates in the femoral vein In the leg and foot it is accompanied by the saphenous nerve. It is formed by the union of the medial dorsal digital vein of the great toe with the medial end of the dorsal venous arch ; it receives communicating veins from the small saphenous and anterior and posterior tibial veins.

Cutaneous Nerves.—(1) The *posterior femoral cutaneous nerve.* Its terminal portion accompanies the small saphenous vein and terminates usually at the middle of the back of the leg. (2) The *sural nerve* is formed by the union of the medial sural cutaneous and peroneal anastomotic nerves opposite the middle of the back of the leg. It accompanies the distal part of the small saphenous vein and is then continued along the lateral side of the dorsum of the foot as the lateral dorsal cutaneous nerve. (3) The *saphenous nerve* is seen along the medial side of the back of the leg running in company with the great saphenous vein. (4) The *posterior branch of the medial femoral cutaneous nerve* lies close behind the saphenous nerve and supplies the skin of the upper and medial part of the back of the leg. (5) The *medial calcaneal branch* of the tibial nerve pierces the laciniate ligament stretching between the end of the medial malleolus and the medial side of the heel. It is distributed to the skin of the heel and the medial margin of the sole of the foot.

Remove the fatty superficial fascia and clean the deep fascia.

The **Deep Fascia** of the back of the leg is comparatively thin. Medially it is attached to the medial border of the tibia. Laterally it is continuous with the deep fascia covering the peronæi muscles. Above it is continuous with the deep fascia covering the popliteal fossa. Below, as it lies in the interval between the end of the medial malleolus and the medial margin of the heel, it becomes thickened and forms a special band, the laciniate ligament.

Dissection. Make a vertical incision in the deep fascia along the middle line of the back of the leg, keeping the laci-

niate ligament intact. The muscles of the calf are now to be cleaned and studied.

The **Gastrocnemius** arises by two heads, medial and lateral. The *medial head* is larger and arises from the rough depression above the posterior part of the medial condyle of the femur, and from a rough surface upon the adjoining popliteal surface of the bone. The *lateral head* arises from an impression on the lateral surface of the lateral condyle of the femur and from the lower part of the lateral epicondylar ridge. Both heads also take their origin from the articular capsule of the knee joint. The two heads converge and meet together and end in a flattened tendon developed on their anterior aspects. This tendon becomes narrow and blends about the middle of the leg with the tendon of the soleus to form the tendo calcaneus. The muscle is supplied by the tibial nerve which gives a branch to each head. It extends the ankle joint and also flexes the knee joint.

Dissection. Divide the two heads of the gastrocnemius transversely and reflect them upwards. Note that a mucous bursa is interposed between the medial head and the articular capsule. The soleus and plantaris are now exposed.

The **Plantaris** arises (1) from the lateral epicondylar ridge above and medial to the origin of the lateral head of the gastrocnemius and (2) from the oblique popliteal ligament of the knee joint. The fleshy belly that is formed is three to four inches in length and ends in a long slender tendon which passes obliquely downwards and medialwards between the gastrocnemius and the soleus It then descends along the medial border of the tendo calcaneus to be inserted with it into the posterior surface of the calcaneus. Sometimes it is inserted into the deep fascia covering it or is blended with the tendo calcaneus. The plantaris is supplied by the tibial nerve. It helps the gastrocnemius in its actions.

The **Soleus** is a very thick muscle. It arises (1) from the posterior surface of the head and the upper third of the posterior surface of the body of the fibula; (2) from the popliteal line and the middle third of the medial border of the tibia; and (3) from the fibrous arch which bridges over the posterior tibial vessels between the two bones of the leg. The muscle ends in a thick tendon which blends with the tendon of the gastrocnemius covering it and forms the tendo calcaneus. The muscle is supplied by the tibial nerve. It extends the ankle joint.

The **Tendo Calcaneus** (tendo Achillis) is the common tendon of the gastrocnemius and soleus and is the strongest tendon in the body. It begins at about the middle of the leg and passes downwards receiving the fleshy fibres of the soleus up to its lower end. It expands slightly before its insertion into the middle portion of the posterior surface of the calcaneus.

Dissection. Divide the plantaris at the middle of its fleshy belly. Divide the soleus transversely before its union with the gastrocnemius and reflect it with the tendo calcaneus downwards. Note the mucous bursa that is interposed between the tendo calcaneus and the smooth upper portion of the posterior surface of the calcaneus. Divide the attached fleshy mass of the soleus vertically along the middle line and detach it at its origin from the popliteal line of the tibia and the fibrous arch over the posterior tibial vessels. Reflect the divided muscle to either side. The deep transverse fascia of the leg, which forms a *fascial septum* and separates the superficial from the deep group of muscles, is exposed. Note that a *fascial compartment* is formed between it and the deep fascia of the leg and contains the gastrocnemius, soleus and plantaris.

The *deep transverse fascia of the leg* is attached medially to the medial border of the tibia and laterally to the postero-lateral border of the fibula. Above it is attached to the popliteal line of the tibia. Below it is thick and is continuous with the laciniate ligament. It separates the superficial muscles of the calf, viz., the gastrocnemius, the soleus, and the plantaris from the deep muscles.

Dissection. Remove the deep transverse fascia of the leg keeping the laciniate ligament intact. Clean the flexor hallucis longus lying along the lateral side of the leg and the flexor digitorum longus lying medially. When these muscles have been cleaned hook the flexor hallucis longus laterally and trace the popliteal artery to its bifurcation into the anterior and posterior tibial arteries at the lower border of the popliteus. Trace the posterior tibial recurrent branch of the anterior tibial artery before it pierces through the interosseous membrane to gain the front aspect of the leg. Next follow the branches of the posterior tibial artery. The largest branch is the peroneal artery given off about an inch distal to the commencement of the posterior tibial artery. Trace the peroneal artery lateralwards towards the fibula and then

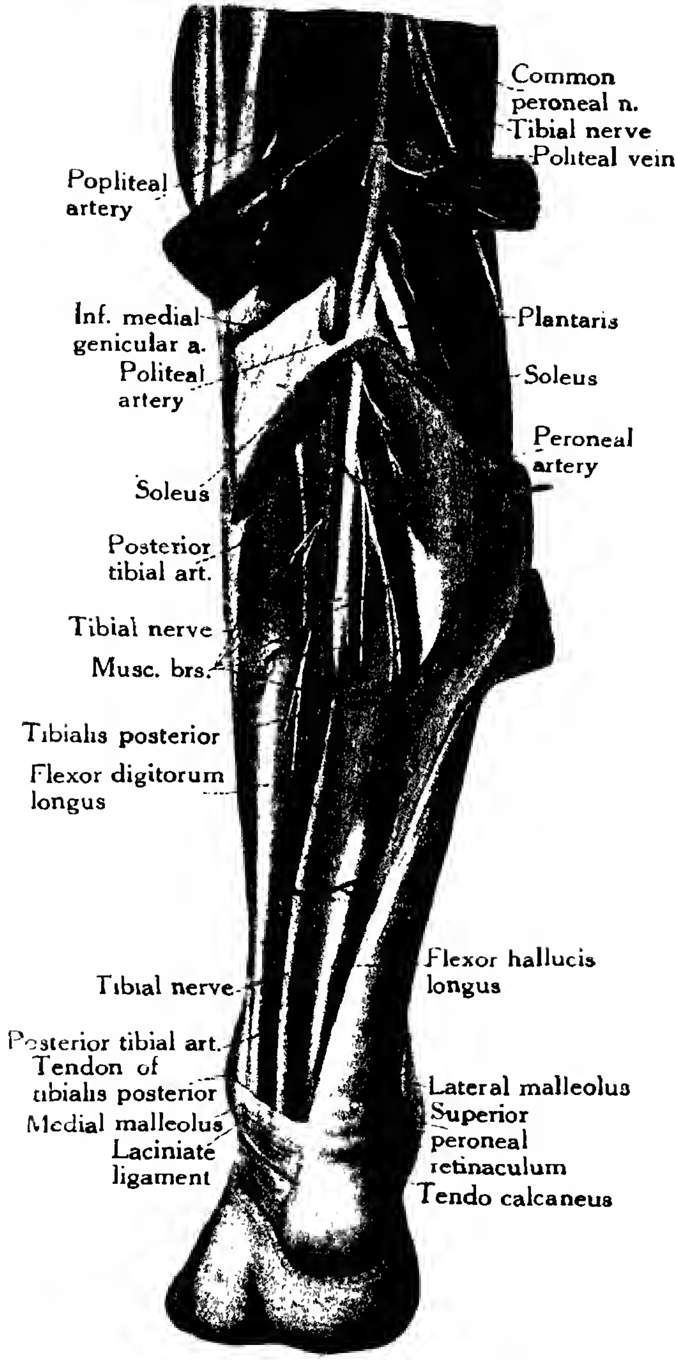


Fig. 176.—Dissection of the popliteal fossa and the posterior region of the leg (Sobotta)

along a fibrous canal either between the origins of the tibialis posterior and flexor hallucis longus or through the substance of the latter muscle. Follow its terminal branches on the lateral side of the heel. Note its perforating branch which gains the front of the leg through the interosseous membrane about two inches above the lateral malleolus. Clean the muscular branches of the posterior tibial artery. Trace the posterior medial malleolar branch medially to the medial malleolus and the communicating branch passing transversely lateralwards to join the communicating branch of the peroneal artery about two inches above the ankle joint. The median calcaneal branches will be seen perforating the laciniate ligament. Lastly clean the muscular branches given off from the tibial nerve in the upper part of the leg to the deep muscles. When these vessels and nerves have been cleaned hook them aside and note that a transverse *fascial septum* covers the tibialis posterior. This septum is attached above to the upper part of the oblique popliteal line of the tibia; medially to the vertical ridge descending from the middle of the popliteal line; and laterally to the posteromedial border of the fibula. Thus a *fascial compartment* is formed between it and deep transverse fascia of the leg and contains the flexor hallucis longus and flexor digitorum longus together with the posterior tibial vessels and tibial nerve. Remove this fascial septum covering the tibialis posterior and note that the muscle takes its origin from the deep surface of the fascia. Clean the tibialis posterior.

The **Flexor Digitorum Longus** arises (1) from the middle two-fourths of the posterior surface of the body of the tibia below the popliteal line and medial to the vertical ridge descending from it; and (2) from the fascia covering the tibialis posterior. The muscle ends in a tendon which passes along the groove behind the medial malleolus with the tendon of the tibialis posterior. It then passes beneath the laciniate ligament into the sole of the foot where it will be subsequently examined. The muscle is supplied by the tibial nerve. It flexes the phalanges, extends the ankle joint and inverts the foot.

The **Flexor Hallucis Longus** arises (1) from the posterior surface of the body of the fibula below the origin of the soleus, except one inch of its lowest part; (2) from the posterior fibular intermuscular septum; and (3) from the fascia covering the tibialis posterior. The muscle ends in a tendon which passes through a shallow groove at the back part of the lower end of

the tibia and then through a deep groove on the posterior border of the talus and reaches the sole of the foot by passing beneath the laciniate ligament. The muscle is supplied by the tibial nerve. It flexes the great toe, extends the ankle joint and inverts the foot.

The *fascia covering the tibialis posterior* is attached medially to the vertical ridge which descends from the popliteal line of the tibia. Laterally it is attached to the posteromedial border of the fibula ; above it is attached to the upper part of the popliteal line of the tibia. Its superficial surface gives origin to the flexores digitorum longus and hallucis longus. Its deep surface gives origin to the tibialis posterior.

The **Tibialis Posterior** lies between the flexor digitorum longus medially and the flexor hallucis longus laterally. It arises (1) from the posterior surface of the body of the tibia extending from the popliteal line above to the junction of the middle and lower thirds of the bone below ; (2) from the medial surface of the body of the fibula ; (3) from the posterior surface of the interosseous membrane except the last two inches ; (4) from the intermuscular septa lying on either side ; and (5) from the deep surface of the fascia covering it. The muscle ends in a strong tendon which passes medialwards in front of the tendon of the flexor digitorum longus to the groove on the back part of the medial malleolus. Here it lies medial to the tendon of the flexor digitorum longus and passes under cover of the laciniate ligament to the sole of the foot. The insertion of the muscle will be seen during the dissection of the sole of the foot. The muscle is supplied by the tibial nerve. It inverts the foot and extends the ankle joint.

The *fascia covering the popliteus* is attached below to the popliteal line of the tibia. Above it receives an expansion from the tendon of insertion of the semimembranosus. Remove this fascia now.

Popliteus.—It arises by a tendon, within the capsule of the knee joint, from the front part of the groove on the lateral surface of the lateral condyle of the femur. This origin will be examined when the joint will be opened. It also arises to a slight extent from the oblique popliteal ligament of the knee joint. The tendon pierces the posterior part of the capsule of the knee joint and ends in a triangular muscle which is inserted (1) into the posterior surface of the tibia above the popliteal line and (2) into the deep surface of the fascia covering it. The popliteus

is supplied by a branch from the tibial nerve which enters its deep surface at the lower border. It rotates the leg inwards and flexes the knee joint.

The **Posterior Tibial Artery** begins at the bifurcation of the popliteal at the lower border of the popliteus. It passes downwards and medialwards and terminates at the lower border of the laciniate ligament and midway between the tip of the medial malleolus and the medial margin of the heel, by dividing into the medial and lateral plantar arteries. In the upper two-thirds of its course it is covered by the superficial group of muscles and the deep transverse fascia of the leg. In the lower third it lies superficially being covered by the superficial and deep fasciæ and runs along the medial side of the tendo calcaneus. From above downwards the vessel lies on the tibialis posterior, the flexor digitorum longus, the lower end of the tibia, and the back part of ankle joint. The tibial nerve lies medial to the artery in the upper third of its course, then crosses the artery superficially and lies on its lateral side in the lower two-thirds. It is accompanied by two venæ comitantes.

The *branches* of the posterior tibial artery are :—(1) nutrient, (2) peroneal, (3) muscular, (4) communicating, (5) posterior medial malleolar, (6) medial calcaneal, (7) medial plantar, and (8) lateral plantar.

(1) The *nutrient artery of the tibia* arises close to the origin of the parent trunk and enters the nutrient foramen of the tibia just below the popliteal line. (2) The *peroneal artery* arises about an inch below the origin of the parent trunk. It passes downwards and lateralwards towards the fibula lying on the surface of the tibialis posterior. It then descends close to the posteromedial border of the fibula and runs either through a fibrous canal between the tibialis posterior and the flexor hallucis longus or through the fibres of the latter muscle. About two inches above the ankle joint it emerges from the flexor hallucis longus, passes behind the inferior tibiofibular joint to the lateral surface of the calcaneus where it divides into lateral calcaneal branches. The *branches* given off from the peroneal artery are :—(*a*) *muscular branches* which supply the adjacent muscles ; (*b*) *nutrient artery of the fibula* which enters the nutrient foramen on the posterior surface of the bone ; (*c*) *perforating branch* (anterior peroneal artery) which pierces the lower part of the interosseous membrane to gain the front aspect of the leg and has already been examined (p. 610) ; (*d*) *communicating branch* which

arises about two inches above the ankle joint and passes transversely medialwards to anastomose with the communicating branch of the posterior tibial artery ; (*e*) *lateral calcaneal branches* which are the terminal branches of the peroneal artery and ramify on the lateral and posterior surfaces of the calcaneus anastomosing with the lateral malleolar arteries. (3) The *muscular branches* supply the soleus and the deep group of muscles. (4) The *communicating branch* arises about two inches above the ankle joint and passes transversely lateralwards under cover of the flexor hallucis longus to anastomose with the communicating branch of the peroneal artery. (5) The *posterior medial malleolar artery* passes medialwards under cover of the flexor digitorum longus and the tibialis posterior, winds round the medial malleolus to anastomose in front of it with the anterior medial malleolar branch of the anterior tibial artery forming the *medial malleolar network*. (6) The *medial calcaneal branches* arise near the termination of the posterior tibial artery. They pierce the laciniate ligament and supply the skin around the heel and the sole of the foot. (7), (8). The *medial* and *lateral plantar arteries* are the terminal branches and will be traced during the dissection of the sole of the foot.

The **Anterior Tibial Artery** is the smaller of the two terminal branches of the popliteal artery. It passes forwards between the two heads of the tibialis posterior and through the aperture at the upper part of the interosseous membrane to gain the front aspect of the leg where it has been examined. On the back of the leg it gives off two *branches* :—(1) The *posterior tibial recurrent artery* which is not always present. It passes upwards under cover of the popliteus, supplies the tibio-fibular joint and anastomoses with the inferior genicular branches of the popliteal artery. (2) The *fibular branch* passes lateralwards behind the neck of the fibula supplying the adjacent muscles. Sometimes this branch arises from the posterior tibial artery.

Crural Portion of Tibial Nerve (Posterior tibial nerve).—The continuation of this nerve from the popliteal fossa should now be traced on the back of the leg. It accompanies the posterior tibial vessels and terminates beneath the laciniate ligament by dividing into the medial and lateral plantar nerves. Its relation to the posterior tibial artery has been already described. Its *branches* in the posterior region of the leg are :—(1) *Medial sural cutaneous nerve* which passes downwards between the two heads of the gastrocnemius and piercing the deep fascia about the middle

of the back of the leg joins the peroneal anastomotic branch to form the sural nerve. (2) *Muscular branches* to the tibialis posterior, flexor hallucis longus, and flexor digitorum longus. (3) *Articular twig* to the ankle joint. (4) The *medial calcaneal branch* is given off beneath the laciniate ligament. It pierces the ligament and becomes cutaneous. Its distribution has been already examined.

The **Laciniate Ligament** (internal annular ligament) extends from the medial malleolus to the medial margin of the calcaneal tuberosity. It is continuous above with the deep fascia and deep transverse fascia of the leg and below with the plantar aponeurosis. It is pierced by the medial calcaneal branches of the posterior tibial artery and the tibial nerve. It gives origin to the abductor hallucis and from its medial surface septa are given off which separate the tendons passing beneath it from each other and from the nerve and blood vessels. The structures passing beneath it lie in the following order :—from the medial to the lateral side (1) the tendon of the tibialis posterior, (2) the tendon of the flexor digitorum longus, (3) the posterior tibial vessels, (4) the tibial nerve, (5) the tendon of the flexor hallucis longus. Divide the laciniate ligament opposite each tendon and exhibit the septa ; note also that each tendon is enclosed by a separate mucous sheath. Proximally these three mucous sheaths terminate almost at the same level viz., at the proximal part of the medial malleolus. But distally they end at different levels. Thus the mucous sheath around the tendon of the tibialis posterior extends almost to its insertion into navicular bone. That around the flexor hallucis longus extends to the base of the first metatarsal bone. The sheath around the flexor digitorum longus terminates midway between the distal ends of the other two sheaths.

THE SOLE OF THE FOOT

Directions. The part should be fixed with the sole of the foot turned towards the dissector, the heel directed upwards and the front of the ankle resting on a block.

Dissection. The skin is to be raised in two flaps by means of two *incisions* : (1) A longitudinal incision from the heel to the root of the middle toe along the middle line of the sole of the foot ; (2) a curved incision along the roots of the toes from the medial to the lateral margin of the foot. The flaps of skin are

to be reflected on either side. The skin from each of the toes should be reflected by a longitudinal incision along the middle line of its plantar surface.

The following structures will be displayed in this dissection :—

Fasciæ	1. Superficial fascia. 2. Plantar aponeurosis.	
Muscles	1. Abductor hallucis. 2. Abductor digiti quinti. 3. Flexor digitorum brevis.	First layer.
	4. Tendon of flexor digitorum longus. 5. Quadratus plantæ. 6. Tendon of flexor hallucis longus. 7. Lumbricales.	Second layer.
	8. Flexor hallucis brevis. 9. Adductor hallucis. 10. Flexor digiti quinti brevis.	Third layer.
	11. Interossei. 12. Tendon of peronæus longus. 13. Tendon of tibialis posterior.	Fourth layer.
Vessels	1. Lateral plantar vessels with their branches including the plantar arch. 2. Medial plantar vessels with their branches.	
Nerves	1. Lateral plantar nerve with its branches. 2. Medial plantar nerve with its branches.	

The **Superficial Fascia** is very thick and contains much granular fat ; the fat is abundant over the parts which press against the ground in standing. Fibrous septa which pass through the superficial fascia and connect the skin to the subjacent plantar aponeurosis subdivide the fat into lobules.

Dissection. Make a longitudinal incision in the superficial fascia along the middle line of the sole of the foot and reflect it on either side. While reflecting it note the cutaneous nerve filaments and vascular twigs perforating the plantar aponeurosis at the lines of junction of its intermediate with the lateral and medial portions. Also note the medial calcaneal branch of the tibial nerve ramifying in the superficial fascia on the medial and back part of the sole of the foot. Opposite the clefts between the toes and also along the medial and lateral margins of the front part of the foot the superficial fascia should be removed carefully so that the nerves and blood vessels going to the toes may not be injured as they are not covered by the plantar aponeurosis in these situations. A band of transverse fibres, called the *superficial transverse ligament of the toes*, crosses the roots of the toes and lies in the skin forming the web of the

foot. Beneath it the digital vessels and nerves proceed to the toes.

The **Plantar Aponeurosis** (Plantar fascia) consists of three portions, an intermediate, a lateral and a medial. The *intermediate portion* is the strongest and thickest portion. It is narrow behind where it is attached to the medial process of the calcaneal tuberosity. It is expanded in front and opposite the heads of the metatarsal bones splits into five processes for the five toes. Each process again subdivides into a superficial and a deep stratum. The superficial stratum is attached to the skin at the roots of the toes. The deep stratum passes forwards to the plantar aspect of a toe and subdivides into two slips which embrace the sides of the fibrous sheaths of the flexor tendons of the toes and blend with them and with the transverse metatarsal ligament extending between the heads of the metatarsal bones. Scattered transverse fibres pass along the angles of splitting of the five processes. In the intervals between these processes the plantar metatarsal arteries, the common plantar digital

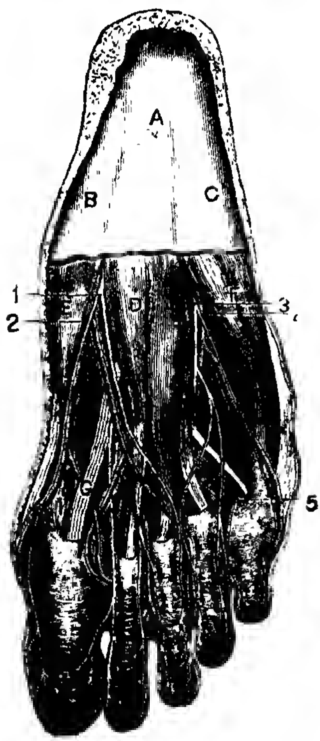


Fig. 177—Superficial dissection of the sole of the foot. (Modified from Hirschfeld and Leveille).

A. Plantar aponeurosis (intermediate portion).

B. The same (medial portion).

C. The same (lateral portion).

D. Flexor digitorum brevis.

E. Abductor hallucis.

F. Abductor digiti quinti.

G. Tendon of flexor hallucis longus.

H. One of the lumbricales.

I. Flexor hallucis brevis.

1. Medial plantar nerve.

2 Medial plantar artery.

3. Lateral plantar nerve.

4. Lateral plantar artery.

5. Common digital nerve from lateral plantar.

nerves, and the lumbrical muscles are seen. The intermediate portion of the aponeurosis covers the flexor digitorum brevis. The *lateral portion* of the aponeurosis is thin, except at its lateral part where a thickened band extends from the lateral process of the calcaneal tuberosity to the base of the fifth metatarsal bone. It covers the abductor digiti quinti and is continuous along the lateral margin of the foot with the deep fascia on the dorsum. The *medial portion* of the aponeurosis is also thin and covers the abductor hallucis. It is continuous along the medial margin of the foot with the deep fascia on the dorsum.

Dissection. Divide the intermediate portion of the plantar aponeurosis two inches in front of its attachment to the calcaneal tuberosity by a transverse incision and reflect the distal portion forwards. Note the two vertical septa which pass upwards from the aponeurosis at the lines of junction of its intermediate portion with the medial and lateral portions. These two intermuscular septa separate the flexor digitorum brevis from the abductor hallucis medially and from the abductor digiti quinti laterally. Remove the medial and lateral portions of the aponeurosis carefully separating them from the abductor hallucis and abductor digiti quinti respectively—as they take their origin from the deep surface of the aponeurosis. Similarly remove the back part of the intermediate portion of the plantar aponeurosis carefully separating it from the flexor digitorum brevis which takes its origin from the deep surface of the aponeurosis. In the interval between the abductor hallucis which lies medially and the flexor digitorum brevis which lies in the middle look for the medial plantar vessels and nerve. Trace the nerve distally and clean its four terminal digital branches—one to the medial side of the great toe, the second to the contiguous sides of the great and second toes and the third to the contiguous sides of the second and third toes and the fourth to the contiguous sides of the third and fourth toes. More proximally the branches of the medial plantar nerve to the abductor hallucis and flexor digitorum brevis are to be secured. Trace the branches of the medial plantar artery accompanying the branches of the medial plantar nerve. In the distal portion of the interval between the abductor digiti quinti laterally and the flexor digitorum brevis in the middle look for the lateral plantar vessels and nerve. Trace the digital branches of the superficial division of the lateral plantar nerve. One goes to the lateral side of the little toe and the other supplies the contiguous sides

of the fourth and fifth toes. The digital branch to the lateral side of the little toe supplies a twig to the flexor digiti quinti brevis and branches to the interossei muscles of the fourth space, which should be secured. The deep division of the lateral plantar nerve with the lateral plantar artery passes deeply and disappears from the present field of dissection at the level of the base of the fifth metatarsal bone. Lastly clean the four tendons of the flexor digitorum brevis occupying the central area and the lumbrical muscles which appear in the gaps between them.

The **Abductor Hallucis** arises (1) from the medial margin of the medial process of the calcaneal tuberosity; (2) from the laciniate ligament; (3) from the intermuscular septum between it and the flexor digitorum brevis; and (4) from the medial portion of the plantar aponeurosis covering it. It ends in a tendon which is blended with the medial head of the flexor hallucis brevis and is inserted into the medial side of the base of the first phalanx of the great toe. It is supplied by a branch from the medial plantar nerve. It flexes the metatarsophalangeal joint of the great toe and draws that toe medialwards.

The **Flexor Digitorum Brevis** arises (1) from the anterior aspect of the medial process of the calcaneal tuberosity; (2) from the deep surface of the intermediate portion of the plantar aponeurosis covering it; and (3) from the intermuscular septa on either side of it. The muscle passes forwards and divides into four tendons for the lateral four toes. Each of these tendons enters the flexor sheath on the plantar aspect of the corresponding toe. Open the flexor sheath of one of the lesser toes and examine the insertion of the tendon. The mode of insertion is similar to that of the flexor digitorum sublimis in the fingers. Opposite the base of the first phalanx each tendon splits into two slips to transmit the corresponding tendon of the flexor digitorum longus. The two slips reunite and split again to be inserted into the margins of the body of the second phalanx at about its middle. The muscle is supplied by a branch from the medial plantar nerve. It flexes first the second phalanges and then the first phalanges.

The **Abductor Digiti Quinti** (abductor minimi digiti)) arises (1) from the lateral process of the calcaneal tuberosity and from the lateral margin of its medial process; (2) from the lateral portion of the plantar aponeurosis covering it; and (3) from the intermuscular septum lying between it and the flexor digitorum brevis. The muscle ends in a tendon which is inserted

into the lateral side of the base of the first phalanx of the little toe. It is supplied by the lateral plantar nerve. It flexes the first phalanx of the little toe and draws it lateralwards.

Dissection. Detach the abductor hallucis at its origin from the calcaneus and turn it medially. Divide the flexor digitorum brevis at the middle of its fleshy belly and throw the distal portion forwards. Trace the proximal portions of the medial and lateral plantar vessels and nerves with their branches. Secure the branches of the lateral plantar nerve to the abductor digiti quinti and the quadratus plantæ. Clean the muscles and tendons of the second layer. The long tendon of the flexor hallucis longus lies medially and the tendon of the flexor digitorum longus lies to its lateral side. Note the four divisions of the flexor digitorum longus with the origins of the lumbrical muscles from them. When cleaning the quadratus plantæ note its insertion into the lateral side of the tendon of the flexor digitorum longus.

The **Medial Plantar Artery** (internal plantar artery) is the smaller of the two terminal branches of the posterior tibial artery. At first it lies covered by the laciniate ligament and then by the abductor hallucis. It next passes forwards lying between the abductor hallucis and the flexor digitorum brevis and terminates by anastomosing with the plantar digital artery at the medial side of the great toe. *Branches.*—(1) *Muscular branches* supply the neighbouring muscles. (2) *Cutaneous branches* perforate the plantar aponeurosis to supply the skin. (3) *Three superficial digital branches* accompany the first three common plantar digital branches of the medial plantar nerve to the clefts between the toes and end by joining the first, second, and third plantar metatarsal arteries respectively.

The **Lateral Plantar Artery** (external plantar artery) is the larger of the two terminal branches of the posterior tibial artery and lies at its origin under cover of the laciniate ligament and the abductor hallucis. It runs obliquely lateralwards lying between the flexor digitorum brevis and the quadratus plantæ. It then turns forwards between the flexor digitorum brevis and the abductor digiti quinti to the base of the fifth metatarsal bone. Here it turns medialwards to form the plantar arch under cover of the flexor tendons. This last portion will be fully exposed at a subsequent stage of the dissection. The artery is accompanied by the lateral plantar nerve. The branches given off from the portion of the artery now exposed are :—(1) *medial calcanean branches* which supply the medial side of the heel ;

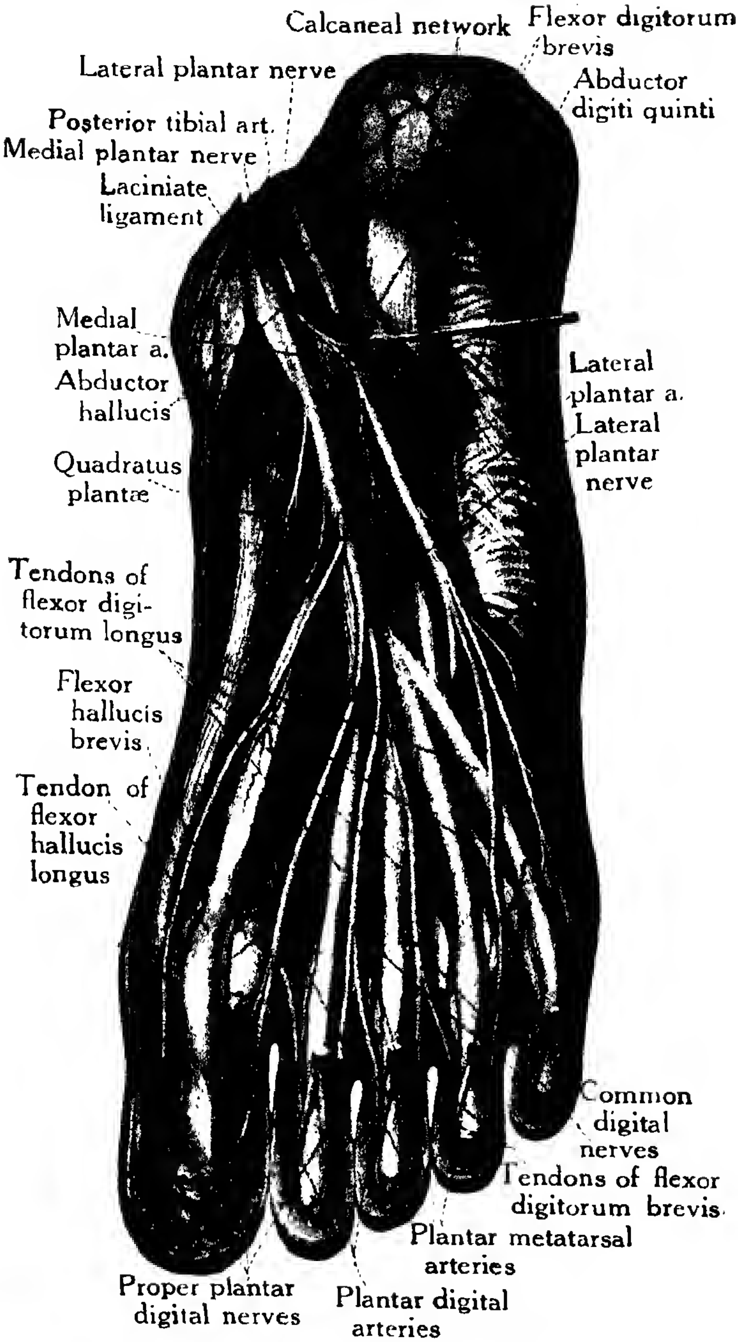


Fig. 178.—Deep dissection of the sole of the foot (Sobotta).

(2) *muscular branches* which supply the neighbouring muscles; (3) *cutaneous branches* which pierce the plantar aponeurosis at the line of union of its lateral and intermediate portions to supply the skin of the sole and of the foot; (4) branches to the lateral margin of the foot.

The **Medial Plantar Nerve** (internal plantar nerve) is larger than the lateral plantar nerve. It accompanies the medial plantar artery and hence has the same course and relations. It arises under cover of the laciniate ligament, passes beneath the abductor hallucis and appears in the interval between this muscle and the flexor digitorum brevis where it ends by dividing into three common digital nerves. Its *branches* are :—(1) *muscular* which arise from the proximal part of the nerve and supply the abductor hallucis and the flexor digitorum brevis; (2) *cutaneous* which pierce the plantar aponeurosis at the line of union of its medial and intermediate portions; (3) *proper digital nerve to the medial side of the great toe* which supplies the medial side of the great toe and the flexor hallucis brevis; and (4) *three common plantar digital nerves* which pass forwards to the clefts between the four medial toes, where each divides into two proper digital nerves. The first common digital nerve supplies a twig to the first lumbrical muscle and its proper digital branches supply the contiguous sides of the great and second toes. The proper digital branches of the second common digital nerve supply the contiguous sides of the second and third toes. The third common digital nerve receives a communicating filament from the superficial branch of the lateral plantar nerve and its proper digital branches supply the contiguous sides of the third and fourth toes. The distribution of these proper digital nerves to the sides and tips of the toes is similar to that of the median nerve in the hand.

The **Lateral Plantar Nerve** (external plantar nerve) is smaller than the preceding nerve. It passes in company with the lateral plantar artery obliquely forwards and lateralwards and rests between the flexor digitorum brevis and quadratus plantæ Reaching the interval between the flexor digitorum brevis and abductor digiti quinti opposite the base of the fifth metatarsal bone, it divides into a superficial and a deep branch. The deep branch accompanies the plantar arch and will be traced later on. The *branches* given off from the trunk of the lateral plantar nerve are :—(1) *muscular branches* to the quadratus plantæ and the abductor digiti quinti; and (2) *cutaneous branches* which perforate

the plantar aponeurosis at the line of the union of its lateral and intermediate portions. The *superficial branch* of the lateral plantar nerve divides into a *proper digital nerve* and a *common plantar digital nerve.* The former supplies the lateral side of the little toe, the flexor digiti quinti brevis and the interosseous muscles of the fourth intermetatarsal space. The latter communicates with the third common digital branch of the medial plantar nerve and divides into two proper digital nerves which supply the contiguous sides of the fourth and fifth toes. The distribution of the lateral plantar nerve is similar to that of the ulnar nerve in the palm.

Dissection. Detach the abductor digiti quinti from its origin and reflect it forwards. Detach the abductor hallucis from the laciniate ligament and throw it medially. The structures constituting the second layer of the sole of the foot are now fully exposed.

In the sole of the foot the **tendon of the flexor digitorum longus** passes forwards and lateralwards crossing the tendon of the flexor hallucis longus superficially. It receives a tendinous slip from the flexor hallucis longus. This tendinous slip is received when the tendons cross each other. Then it receives the insertion of the quadratus plantæ laterally. Finally it divides into four tendons which proceed to the lateral four toes. The lumbrical muscles arise from these tendons. Each tendon passes along the plantar surface of one of the lesser toes and is enclosed in a fibrous sheath together with a tendon of the short flexor. Lay open one of these fibrous flexor sheaths and note the passage of the tendon of the long flexor through an opening in the tendon of the flexor digitorum brevis to its insertion into the plantar surface of the base of the last phalanx.

The **tendon of the flexor hallucis longus** passes to the sole of the foot through the groove on the under surface of the sustentaculum tali. It then passes forwards and medialwards lying deep to the tendon of the flexor digitorum longus to which it is connected by a tendinous slip. On reaching the great toe it passes along its plantar surface and is retained in position by a fibrous sheath. The tendon is inserted into the plantar aspect of the base of the last phalanx of the great toe.

The **Quadratus Plantæ** (flexor accessorius) has two heads of origin, medial and lateral. The *medial head* arises by fleshy fibres from the medial concave surface of the calcaneus. The *lateral head* arises by tendinous fibres (1) from the inferior sur-

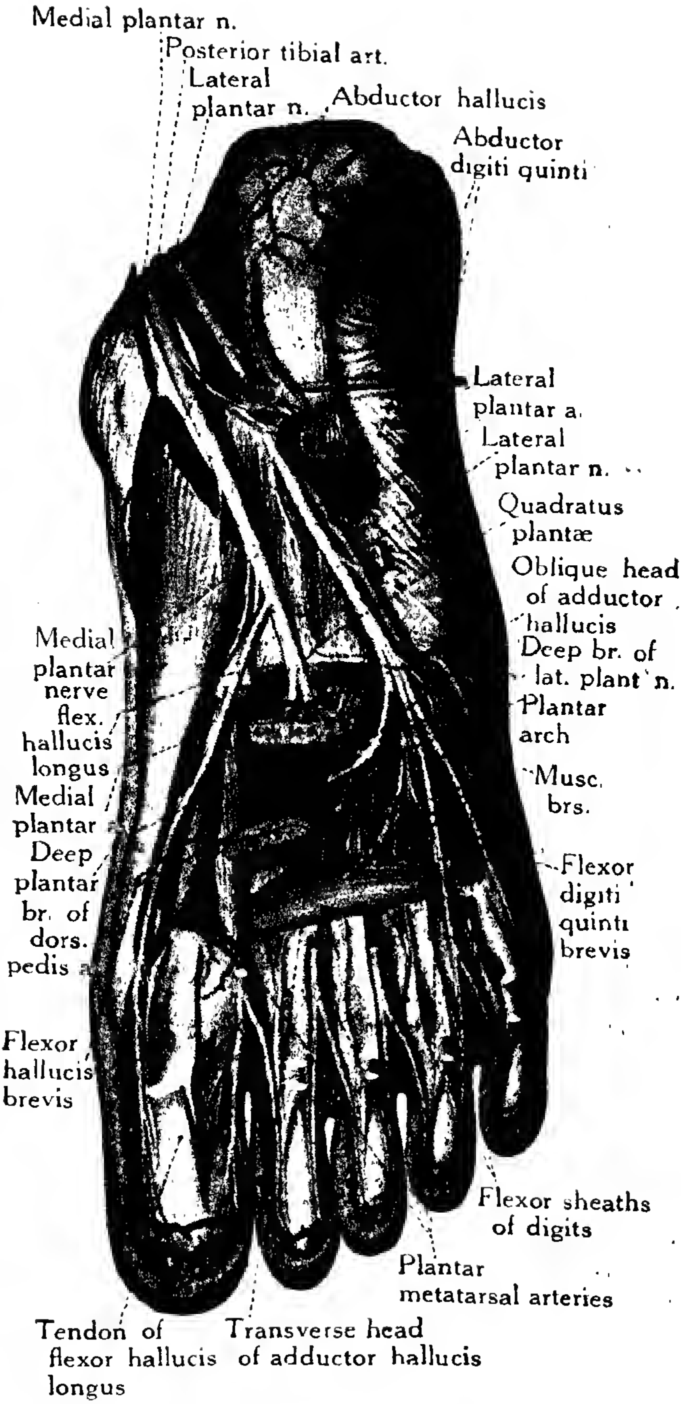


Fig. 179.—Deep dissection of the sole of the foot. The deeper structures have been displayed.

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face of the calcaneus in front of the lateral process of its calcaneal tuberosity ; and (2) from the long plantar ligament. The muscle is inserted on the lateral side of the tendon of the flexor digitorum longus at about the middle of the sole of the foot. It is supplied by the lateral plantar nerve. It assists the flexor digitorum longus and counteracts the oblique pull of its tendons on the toes . the combined action of the two muscles therefore flexes the toes directly backwards.

The **Lumbricales** are four in number and arise from the tendons of the flexor digitorum longus. The *first* or the most medial one arises from the medial side of the tendon of the long flexor to the second toe. The *second, third,* and *fourth* arise from the contiguous sides of the tendons of the long flexor to the third, fourth, and fifth toes. They proceed forwards and each ends in a tendon which passes backwards along the medial side of the base of the corresponding toe to be inserted into the expansion of the extensor tendon on the dorsum of the first phalanx. The first lumbrical muscle is supplied by the medial plantar nerve and the others by the lateral plantar nerve. The lumbricales flex the proximal phalanges but extend the middle and terminal phalanges on account of their insertion into the dorsal expansions of the extensor tendons.

Flexor Sheaths.—The flexor tendons are retained along the plantar surfaces of the toes by means of fibrous sheaths like those found in the fingers (p. 538). They form osseofibrous canals, bounded dorsally by the phalanges and on the plantar aspects by fibrous bands which become fixed to the margins of the phalanges. Within each canal two tendons are seen and opposite the middle of the first phalanx the tendon of the long flexor perforates the tendon of the short flexor. The ultimate insertions of these two tendons have been examined. The fibrous sheath is strengthened by transverse bands, the *vaginal ligaments*, opposite the bodies of the proximal and middle phalanges. Each canal contains a mucous sheath; within this sheath are seen vincula, short and long, like those of the fingers.

Dissection. Divide the quadratus plantæ at its origin and the tendons of the flexor hallucis longus and flexor digitorum longus at the lower border of the laciniate ligament and throw them forwards. This brings into view (1) the third layer of muscles ; (2) the plantar arch ; and (3) the deep branch of the lateral plantar nerve.

The **Flexor Hallucis Brevis** arises from the under surface

of the cuboid and from the slip of the tendon of the tibialis posterior which is attached to the third cuneiform bone. In front it divides into two portions, a medial and a lateral. The medial portion ends in a tendon which is blended with that of the abductor hallucis and is inserted into the medial side of the base of the first phalanx of the great toe. The lateral portion ends in a tendon which blends with that of the adductor hallucis and is inserted into the lateral side of the base of the first phalanx of the great toe. A sesamoid bone is developed in each tendon of insertion. The muscle is supplied by the medial plantar nerve. It flexes the proximal phalanx of the great toe.

The **Adductor Hallucis** presents two separate heads of origin, an oblique and a transverse. The *oblique head* (adductor obliquus hallucis) arises from the plantar aspects of the bases of the second, third, and fourth metatarsal bones and from the sheath of the tendon of the peronæus longus ; it passes obliquely forwards and medialwards and is inserted with the lateral portion of the flexor hallucis brevis into the lateral side of the base of the first phalanx of the great toe. The *transverse head* (adductor transversus hallucis) arises from the plantar metatarso-phalangeal ligaments of the third, fourth and fifth toes and from the transverse metatarsal ligament ; it passes transversely medialwards and is inserted, in common with the tendon of insertion of the oblique portion, into the lateral side of the base of the first phalanx of the great toe. The muscle is supplied by the deep branch of the lateral plantar nerve. The oblique head at first adducts the great toe and then flexes it. The transeverse head at first adducts the great toe to the others and then approximates the remaining toes.

The **Flexor Digiti Quinti Brevis** (flexor brevis minimi digiti) arises from the base of the fifth metatarsal bone and from the sheath of the tendon of the peronæus longus. It is inserted into the lateral side of the base of the first phalanx of the little toe. It is supplied by the superficial branch of the lateral plantar nerve. It flexes the little toe.

Dissection. Detach the oblique head of the adductor hallucis and the flexor hallucis brevis at their origins and reflect them forwards. This brings into view : (1) the terminal part of the lateral plantar artery proceeding to form the plantar arch ; (2) the deep branch of the lateral plantar nerve accompanying the artery ; and (3) the deep plantar artery which is the termination of the dorsalis pedis artery.

The **Plantar Arch** is the portion of the lateral plantar artery which extends from the base of the fifth metatarsal bone to the proximal part of the first intermetatarsal space where it is joined by the deep plantar branch of the dorsalis pedis artery.

The *branches* given off from this arch are :—(1) The *posterior perforating branches.* These are three in number and pass dorsally through the back part of the second, third, and fourth interosseous spaces to join the corresponding dorsal metatarsal arteries. (2) The *plantar metatarsal arteries* are four in number and pass forwards, one in each intermetatarsal space ; each divides opposite the cleft between two adjacent toes into two plantar digital branches which supply the contiguous sides of these toes. Before division each plantar metatarsal artery sends dorsally an *anterior perforating branch* which joins the corresponding dorsal metatarsal artery between the heads of the metatarsal bones. The *first plantar metatarsal artery,* (arteria magna hallucis), arises from the junction of the lateral plantar with the deep plantar artery and before division sends a digital branch to the medial side of the great toe which is joined by the terminal part of the medial plantar artery. The digital branch for the lateral side of the little toe arises from the lateral end of the plantar arch.

The *deep branch of the lateral plantar nerve* accompanies the plantar arch. It rigidly follows the arch, lies posterior to it and ultimately ends in the oblique head of the adductor hallucis. It supplies the second, third and fourth lumbricales ; both heads of the adductor hallucis ; and all the interosseous muscles except those of the fourth intermetatarsal space.

Dissection. Divide the transverse head of the adductor hallucis close to its origin and reflect it towards the great toe. The transverse metatarsal ligament is exposed.

The *transverse metatarsal ligament* stretches across and connects the plantar aspects of the heads of all the metatarsal bones. It is continuous in front with the accessory plantar ligaments of the metatarsophalangeal joints.

Dissection. Divide this transverse ligament between the heads of the metatarsal bones. The interosseous muscles are now fully exposed.

The **Interosseous Muscles** are situated in the intervals between the metatarsal bones and consist of two sets, plantar and dorsal, like those in the hand. Two interossei are found in each intermetatarsal space, except the innermost.

The **Plantar Interossei** are three in number and belong to lateral three toes. They arise from the bases and medial surfaces of the bodies of the third, fourth, and fifth metatarsal bones. Each muscle is connected with only one metatarsal bone and is rather placed beneath the bone than between two contiguous bones. Each is inserted into the medial side of the base of the first phalanx of the corresponding toe and into the expansion of the extensor tendon on its dorsum. They are supplied by the lateral plantar nerve. They adduct the third, fourth and fifth toes towards the middle line of the second toe.

The **Dorsal Interossei** are four in number ; one in each intermetatarsal space. Each arises by two heads from the contiguous surfaces of two metatarsal bones between which it lies. The first dorsal interosseous muscle is inserted into the medial side of the base of the first phalanx of the second toe. The second, third, and fourth dorsal interossei are inserted into the lateral sides of the bases of the first phalanges of the corresponding toes. The dorsal interossei are also inserted into the expansions of the extensor tendons on the dorsal aspect of the toes. They are supplied by the lateral plantar nerve. The first dorsal interosseous sometimes gets an additional nerve supply from the medial terminal branch of the deep peroneal nerve and the second dorsal interosseous from the lateral terminal branch of the deep peroneal nerve. They abduct the second, third and fourth toes from the middle line of the second toe.

Insertion of the Tibialis Posterior.—The tendon of the tibialis posterior is mainly inserted into the tuberosity of the navicular bone. It sends tendinous slips for insertion into all the bones of the tarsus except the talus and also into the bases of the second, third, and fourth metatarsal bones.

Insertion of the Peronæus Longus.—As the tendon of the peronæus longus passes along the groove on the plantar surface of the cuboid bone it is contained in a fibrous sheath lined by a synovial stratum. This mucous sheath may be closed at the lateral margin of the foot or may be continuous with the mucous sheath around the tendon on the lateral surface of the calcaneus. Open this sheath and trace the tendon to its insertion into the inferior surface of the base of the first metatarsal bone and into the contiguous part of the first cuneiform bone. A sesamoid bone is developed in the tendon when it turns round the lateral margin of the cuboid.

ARTICULATIONS

Knee Joint.—The knee joint consists in reality of three articulations : one between the patella and the femur which constitutes chiefly an arthrodial joint ; and the other two between each condyle of the femur and the corresponding condylar surface of the tibia which are condyloid joints. The following are the ligaments of the knee joint :—

(1) The *articular capsule* is not uniformly thick on all sides of the joint. Thus it is represented only by the synovial stratum above the patella where it is prolonged upwards beneath the tendon of the quadriceps femoris. It is strengthened medially and laterally by the collateral ligaments. Lateral to the patella, it receives expansions from the tendons of the vasti, from the iliotibial tract, and from the deep fascia of the leg ; medial to the patella, from the tendons of the sartorius and the vasti and from the deep fascia; and posteriorly, from the tendon of the semimembranosus. Above, it is attached to the margins of the articular surfaces of the condyles of the femur and the upper margin of the intercondyloid fossa ; and below, to the circumference of the articular surfaces of the condyles of the tibia.

(2) The *ligamentum patellæ* is the tendon of insertion of the quadriceps femoris. It is attached above to the apex and lower border of the patella and to the rough area on the lower part of its posterior surface. Below it is attached to the lower rough part of the tuberosity of the tibia, a mucous bursa being interposed between the ligament and the upper smooth portion of the tuberosity. Above the tuberosity it rests against a pad of fat (infrapatellar pad) which separates it from the synovial stratum of the joint.

(3) The *oblique popliteal ligament* (posterior ligament) begins from the tendon of the semimembranosus at its insertion into the back part of the medial condyle of the tibia. It passes upwards and lateralwards and becomes attached to the upper margin of the intercondyloid fossa and lateral condyle of the femur. It is perforated by the blood vessels and nerves entering the joint at that part.

(4) The *tibial collateral ligament* (internal lateral ligament) is attached above to the medial epicondyle of the femur below the adductor tubercle, and below, to the medial condyle of the tibia and the medial surface of the body of the tibia immediately below it. It is covered by the tendons of the sartorius, gracilis,

and semitendinosus where a mucous bursa is interposed. The inferior medial genicular vessels and nerve pass under cover of it.

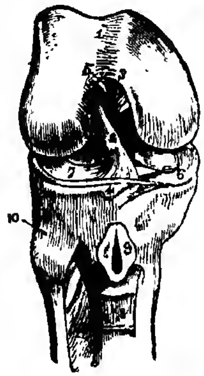

Fig. 180.—The knee joint laid open, showing the interior of the joint (Wilson).

1. Patellar surface of femur.
2. Anterior cruciate ligament.
3. Posterior cruciate ligament.
4. Transverse ligament.
5. Patellar fold of the synovial stratum.
6. Medial meniscus.
7. Lateral meniscus.
8. Ligamentum patellæ.
9. Mucous bursa beneath ligamentum patellæ.
10. Anterior ligament of the head of the fibula.
11. Interosseous membrane.

(5) The *fibular collateral ligament* (external lateral ligament) is attached above to the lateral epicondyle of the femur and below to the lateral surface of the head of the fibula where it splits the tendon of insertion of the biceps femoris into two parts. It covers the tendon of the popliteus which takes its origin inside the joint. The inferior lateral genicular vessels and nerve pass under cover of it.

Dissection. Make a longitudinal incision through the front part of the articular capsule on either side of the patella and throw the patella downwards with the tendon of the quadriceps femoris attached to its base. The synovial stratum is now exposed.

The *synovial stratum* of the knee joint is the largest in the body. It invests the deep surface of the articular capsule and is reflected on to the articular surfaces and to the menisci covering the condyles of the tibia. In front it extends upwards beneath the tendon of the quadriceps femoris over the lower end of the anterior surface of the femur where it forms a pouch which usually communicates with the mucous bursa situated higher up between the tendon and the front of the femur. Below the patella it sends backwards a double triangular fold, called the *patellar fold* (ligamentum mucosum), the apex of which is attached to the anterior margin of the intercondyloid fossa of the femur. The fringed margins of the patellar fold are called the *alar folds* (ligamenta alaria). The synovial stratum is separated from the ligamentum patellæ by a pad of fat called the *infrapatellar*

pad. It covers both surfaces of the menisci and ensheaths the cruciate ligaments in such a way that they are covered by it anteriorly and at the sides but posteriorly they are in direct relation with the fibrous stratum of the posterior part of the articular capsule. In other words the synovial stratum opposite the posterior aspects of the cruciate ligaments leaves the fibrous stratum of the articular capsule and invests the sides and front aspect of the cruciate ligaments leaving their posterior surface in contact with the fibrous stratum of the articular capsule. Thus these cruciate ligaments are outside the synovial stratum but inside the fibrous stratum of the articular capsule. Over the back part of the medial condyle of the femur it sometimes communicates with the mucous bursa situated underneath the medial head of the gastrocnemius. It is prolonged as a sheath on the tendon of the popliteus as it issues out of the joint grooving the posterolateral margin of the lateral meniscus.

Dissection. Divide the articular capsule and the collateral ligaments by a circular cut between the condyles of the femur and tibia. Remove the synovial stratum from the cruciate ligaments and expose them thoroughly.

(6, 7). The *cruciate ligaments* (crucial ligaments) are two in number, an anterior and a posterior. They cross each other like the limbs of the letter **X**. The *anterior cruciate ligament* is attached below to the depression in front of the intercondyloid eminence of the tibia. It passes upwards, backwards and lateralwards and is attached to the back part of the medial surface of the lateral condyle of the femur. The *posterior cruciate ligament* is attached below to the posterior intercondyloid fossa of the tibia, being blended with the posterior end of the lateral meniscus. It passes upwards, forwards and medialwards to be attached to the front part of the lateral surface of the medial condyle of the femur.

Note. The student should verify that both the cruciate ligaments are put on stretch when the knee joint is fully extended. He should also note that internal rotation is also checked by the anterior cruciate ligament being put on stretch, and that both the cruciate ligaments are relaxed during external rotation of the joint as they do not cross in that position of the joint.

Divide the cruciate ligaments.

(8, 9). The *menisci* (semilunar fibrocartilages) are two crescentic plates of fibrocartilage, a medial and a lateral. They cover the peripheral two-thirds of the articular surfaces of the

condyles of the tibia. Their upper surfaces are slightly concave and lower surfaces almost flat. Both surfaces are covered by the synovial stratum of the joint. Their peripheral margins are thick and convex, while their free margins are thin and concave. The *medial meniscus* is almost semicircular and more elongated than the lateral one. Its ends embrace the ends of the lateral meniscus. Its anterior end is attached to the anterior intercondyloid fossa in front of the attachment of the anterior cruciate ligament and the anterior end of the lateral meniscus. Its posterior end is attached to the posterior intercondyloid fossa in front of the attachment of the posterior cruciate ligament and behind that of the posterior end of the lateral meniscus. Its peripheral margin is attached to the fibrous capsule of the joint. The *lateral meniscus* is nearly circular. Its anterior end is attached in front of the intercondyloid eminence behind the attachment of the anterior cruciate ligament. Its posterior end is attached behind the intercondyloid eminence and in front of the posterior end of the medial meniscus and sends a slip to join the posterior cruciate ligament. The posterolateral part of its periphery is grooved for the tendon of the popliteus.

(10) The *transverse ligament* connects the anterior margin of the lateral meniscus with the anterior end of the medial meniscus.

(11) The *coronary ligaments* are merely portions of the fibrous capsule of the joint connecting the periphery of each meniscus to the circumference of the corresponding articular surface on the head of the tibia.

The **Movements** permitted by the knee joint are flexion and extension but there may be in addition medial and lateral rotation. The muscles producing the movements are :—

Flexion—biceps femoris, semimembranosus, semitendinosus, sartorius, gracilis and popliteus ;

Extension—the different portions of the quadriceps femoris ;

Medial rotation—sartorius, gracilis, semimembranosus, semitendinosus and popliteus ;

Lateral rotation—biceps femoris.

Note. The student should carefully examine the articular surfaces of the patella and of the condyles of the femur by procuring a fresh knee joint. On the posterior surface of the patella he will note the seven facets separated from each other by faint ridges and he should make the patella glide on the patellar

surface of the femur to note the facet or facets of the former which successively come into contact with the femur during the various positions of the joint from full extension to full flexion. He should similarly note the gliding movement of the condyles of the femur on the menisci at the head of the tibia during the different movements of the joint. During full extension of the joint the anterior margins of the menisci rest against transverse grooves on the condyles of the femur separating their patellar from the tibial surfaces.

Ankle Joint or **Talocrural Articulation**.—The ankle joint is a ginglymus or hinge-joint. The bones entering into its formation are the lower extremity of the tibia with its malleolus, the lateral malleolus and the superior, medial, and lateral surfaces of the trochlea of the talus. To display the ligaments remove the tendons surrounding the joint. The following are the ligaments of the joint :—

(1) The *articular capsule* surrounds the articular surfaces entering into the formation of the joint. Its anterior portion (anterior ligament) is attached above to the anterior margin of the lower end of the tibia and below to the neck of the talus in front of the dorsal surface of its trochlea. Its posterior portion (posterior ligament) is attached above to the posterior margin of the lower end of the tibia and below to the posterior margin of the trochlear surface of the talus. It is thin and consists mainly of transverse fibres.

(2) The *deltoid ligament* (internal lateral ligament) strengthens the capsule medially. It is triangular in shape and is attached by its apex to the tip and borders of the medial malleolus. Its expanded base is attached in front to the navicular bone ; in the middle, to the medial surface of the talus below the articular surface and to the sustentaculum tali ; and behind, to the tubercle on the posterior surface of the talus medial to the tendon of the flexor hallucis longus.

On the lateral side of the joint there are three bands, the anterior and posterior talofibular ligaments and the calcaneofibular ligament. These strengthen the capsule laterally.

(3) The *anterior talofibular ligament* (anterior fasciculus of external lateral ligament) extends from the anterior margin of the lateral malleolus to the lateral side of the talus in front of its articular surface.

(4) The *posterior talofibular ligament* (posterior fasciculus of external lateral ligament) extends from the depression on the

medial and back part of the lateral malleolus horizontally to the posterior process of the talus.

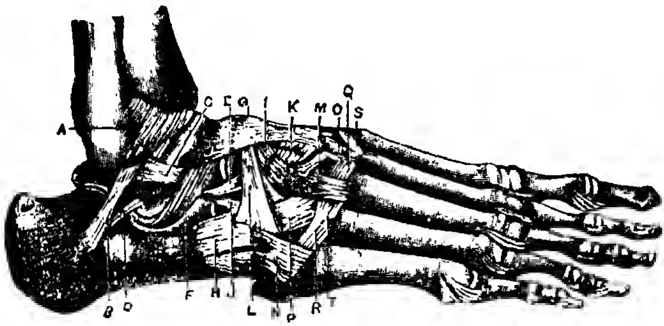

Fig. 181.—Ligaments of the lateral side of the ankle and foot (Sappey).

A. Anterior ligament of the lateral malleolus.
B. Calcaneofibular ligament.
C. Anterior talofibular ligament.
D. Lateral talocalcaneal ligament.
E. Calcaneonavicular part of bifurcated ligament.
F. Interosseous talocalcaneal ligament.
G. Talonavicular ligament.
H. Dorsal calcaneo cuboid ligament.
I. Dorsal ligament between navicular and third cuneiform bone.
J. Calcaneocuboid part of the bifurcated ligament.
K. Dorsal ligament between second and third cuneiform bones.
L. Dorsal ligament between navicular and cuboid bones.
M. Dorsal ligament between third cuneiform and third metatarsal bones.
N. Dorsal ligament between cuboid and fifth metatarsal bone.
O. Dorsal ligament between second cuneiform and second metatarsal bone.
P. Dorsal ligament between cuboid and third and fourth metatarsal bones.
Q. R, S, T, Dorsal ligaments between bases of metatarsal bones.

(5) The *calcaneofibular ligament* (middle fasciculus of external lateral ligament) extends from the tip of the lateral malleolus to the tubercle on the lateral surface of the calcaneus.

Open the articular capsule.

The *synovial stratum* lines the fibrous capsule and is reflected on the articular surfaces of the bones. It sends a process upwards between the tibia and the fibula.

The **Movements** permitted in the ankle joint are flexion or dorsiflexion and extension or plantar flexion. The front part of the trochlea of the talus is wider than the back part. Hence the talus is tightly grasped between the malleoli during dorsiflexion and is loosely grasped during extension. Thus some amount of side to side movement is allowed during extension of the joint. *Dorsiflexion* is produced by the tibialis anterior,

extensor hallucis longus, extensor digitorum longus and peronæus tertius. *Extension* is produced by tibialis posterior, flexor hallucis longus, flexor digitorum longus, peronæi longus and brevis together with the superficial muscles of the calf—viz., the gastrocnemius, soleus and plantaris.

Tibiofibular Joints.—The articulations between the tibia and fibula consist of the proximal and distal tibiofibular joints. The interosseous membrane acts as an accessory ligament to both of these joints.

The *proximal tibiofibular articulation* is an arthrodial joint, the articular surfaces being flat. The ligaments are :—(1) The *articular capsule* which surrounds the articular surfaces ; (2) the *anterior ligament* of the head of the fibula which consists of oblique fibres strengthening the capsule anteriorly. It extends from the front of the lateral condyle of the tibia downwards and lateralwards to the anterior surface of the head of the fibula. (3) The *posterior ligament* of the head of the fibula which strengthens the capsule posteriorly and extends downwards and lateralwards from the back part of the lateral condyle of the tibia to the back part of the head of the fibula. The *synovial stratum* lining the fibrous capsule sometimes communicates with that of the knee joint

Dissection. Remove the muscles from the anterior and posterior aspects of the leg and clean the surfaces of the crural interosseous membrane.

The *crural interosseous membrane* connects together the two bones of the leg extending from the interosseous crest of the tibia to that of the fibula. The fibres are for the most part directed obliquely from the tibia downwards and lateralwards. Below the proximal tibiofibular articulation it presents an aperture for the passage of the anterior tibial vessels ; while a little above the ankle it presents another small aperture for the peroneal vessels. The structures lying in relation with it have been examined.

Tibiofibular syndesmosis (inferior or distal tibiofibular articulation).—The parts entering into the formation of this articulation are the medial surface of the lateral malleolus and the fibular notch on the lateral surface of the lower end of the tibia. At the upper part these surfaces are rough while at the lower part they are smooth and covered with cartilage. The ligaments are :—(1) The *anterior ligament* of the lateral malleolus which passes obliquely downwards and lateralwards from the anterior

border of the fibular notch to the anterior border of the lateral malleolus. (2) The *posterior ligament* of the lateral malleolus consists of oblique fibres passing between the bones posteriorly in a similar manner. (3) The *inferior transverse ligament* is formed by the lower transverse fibres of the posterior ligament and is more deeply placed; these fibres extend below the level of the articulation increasing the extent of the socket for articulation with the talus. (4) The *interosseous ligament* passes between the contiguous rough surfaces of the two bones and is very strong. The *synovial stratum* of the ankle joint is prolonged upwards between the smooth surfaces of the two bones. *Movements.*—Slight gliding movement is permitted in the proximal and distal tibiofibular joints.

Dissection. Remove the remains of the muscles and tendons attached both to the dorsal and plantar aspects of the foot and clean the ligaments.

The **Intertarsal Articulations** are :—

I. **Talocalcaneal Articulation.**—The talus articulates with the calcaneus in two places, in front and behind. The anterior articulation forms part of the talocalcaneo-navicular articulation in which the head of the talus articulates with the sustentaculum tali and the navicular bone. The posterior articulation or *talocalcaneal articulation* is an arthrodial joint and is formed between the posterior calcaneal facet on the inferior surface of the talus and the posterior articular facet on the superior surface of the calcaneus. The ligaments are :—(1) The *articular capsule* which surrounds the articular surfaces. It is lined by a separate synovial stratum. (2) The *lateral talocalcaneal ligament* extends from the lateral surface of the talus below the articular facet to the lateral surface of the calcaneus on a deeper plane than the calcaneofibular ligament of the ankle joint. (3) The *medial talocalcaneal ligament* extends from the medial tubercle on the posterior surface of the talus to the back part of the sustentaculum tali being continuous with the plantar calcaneonavicular ligament. (4) The *anterior talocalcaneal ligament* extends from the anterolateral aspect of the neck of the talus in front of the articular surface to the adjoining superior surface of the calcaneus. (5) The *posterior talocalcaneal ligament* extends from the lateral tubercle on the posterior surface of the talus to the posterior margin of the articular surface of the calcaneus. (6) The *interosseous talocalcaneal ligament* is a very stong band of fibres passing between the two bones. It fills up the

sinus tarsi extending from the sulcus tali to the sulcus calcanei. *Movements.*—The joint being an arthrodial joint permits of a limited gliding movement of the talus on the calcaneus.

II. **Talocalcaneonavicular Articulation.**—This articulation is between the head of the talus, the posterior surface of the navicular bone and the anterior and middle articular areas on the superior surface of the calcaneus. It is an arthrodial joint. The ligaments are :—(1) The *articular capsule* which is very thin and surrounds the articular surfaces. It is lined by a separate synovial stratum. (2) The *talonavicular ligament* extends from the neck of the talus to the dorsum of the navicular bone. (3) The *plantar calcaneonavicular ligament* extends from the anterior margin of the talus to the plantar surface of the navicular bone. It also affords support to the head of the talus. (4) The *calcaneonavicular part of the bifurcated ligament* is attached by its undivided stem to the dorsal surface of the calcaneus just in front of the sulcus calcanei. The bifurcated limb for the navicular bone is attached to its lateral surface. *Movement.*—The joint being an arthrodial joint permits only of a slight gliding movement.

III. The **Calcaneocuboid Articulation** is formed between the anterior surface of the calcaneus and the posterior surface of the cuboid. The ligaments are :—(1) The *articular capsule* which is attached around the circumference of the articular surfaces. It is lined by a separate synovial stratum. (2) The *dorsal calcaneocuboid ligament* strengthens the capsule on the dorsal aspect of the joint. (3) The *calcaneocuboid part of the bifurcated ligament* is attached by its stem to the upper surface of the calcaneus in front of the sulcus calcaneus and by the bifurcated end to the medial surface of the cuboid. (4) The *long plantar ligament* is attached behind to the plantar surface of the calcaneus in front of its tuberosity and in front to the ridge on the plantar surface of the cuboid ; some fibres are prolonged to the bases of the second, third, and fourth metatarsal bones and cover the tendon of the peronæus longus. (5) The *plantar calcaneocuboid ligament* (short plantar ligament) lies deep to the preceding and is attached behind to the tubercle and transverse groove at the front part of the plantar surface of the calcaneus. In front it is attached to the plantar surface of the cuboid behind the ridge. *Movement.*—The articular surfaces are saddle-shaped and permit of a gliding movement only.

IV. The **Cuneonavicular Articulation** is formed between

the anterior surface of the navicular bone and the posterior surfaces of the three cuneiform bones. The ligaments are :—(1)

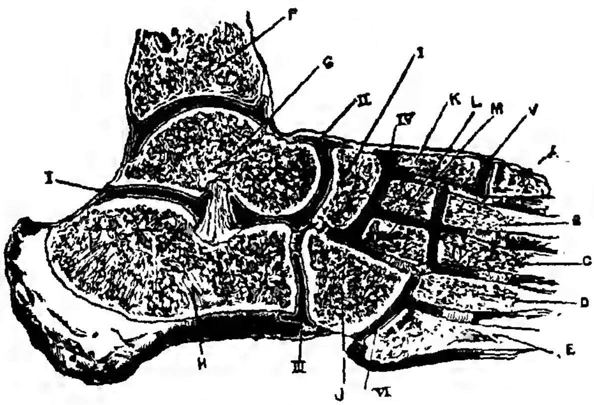

Fig. 182.—Section through the foot showing the six synovial strata.

A. First metatarsal bone.
B. Second metatarsal bone.
C. Third metatarsal bone.
D. Fourth metatarsal bone.
E. Fifth metatarsal bone.
F. Tibia.
G. Talus.
H. Calcaneus.
I. Navicular bone.
J. Cuboid bone.
K. First cuneiform bone.
L. Second cuneiform bone.
M. Third cuneiform bone.
I to VI.—The six synovial strata.

the *dorsal ligaments* which are three slips passing from the dorsal surface of the navicular bone to the dorsal surfaces of the three cuneiform bones. (2) The *plantar ligaments* pass from the plantar surface of the navicular bone to the plantar surfaces of the three cuneiform bones. *Movements.*—It is an arthrodial joint and permits only of gliding movement.

V. **Cuboideonavicular Articulation.**—The cuboid is connected with the navicular bone by the following ligaments : (1) The *dorsal ligament* extends between their dorsal surfaces. (2) The *plantar ligament* extends between their plantar surfaces. (3) The *interosseous ligament* passes transversely between the contiguous surfaces of the two bones. *Movements.*—Only a slight gliding movement is permitted between the two bones.

VI. **Intercuneiform** and **Cuneocuboid Articulations.**—The three cuneiform bones and the cuboid are connected with each other by dorsal, plantar, and interosseous ligaments. The *dorsal ligaments* pass between the dorsal surfaces of the contiguous bones. The *plantar ligaments* pass between their plantar

surfaces. The *interosseous ligaments* extend between the rough surfaces of the contiguous bones. *Movements*.—These are arthrodial joints and permit of gliding movements only.

VII. **Tarsometatarsal Articulations**.—The three cuneiform bones and the cuboid articulate in front with the five metatarsal bones. The ligaments are :—(1) The *dorsal ligaments* which are formed by several strong bands. One band passes from the dorsal surface of the first cuneiform bone to that of the base of the first metatarsal bone ; three bands pass from the three cuneiform bones to the base of the second metatarsal bone ; one band passes from the third cuneiform bone to the third metatarsal bone ; two bands, one from the third cuneiform and another from the cuboid pass to the fourth metatarsal bone ; one band passes from the cuboid to the fifth metatarsal bone. (2) The *plantar ligaments* extend between the plantar surfaces of the two rows, and are not so regularly arranged as the dorsal ligaments. Two oblique bands pass from the plantar surface of the first cuneiform bone to the bases of the second and third metatarsal bones. In addition to the dorsal and plantar ligaments the articulation between the first cuneiform bone and the base of the first metatarsal bone is surrounded by a thin articular capsule lined by a separate synovial stratum. (3) The *interosseous ligaments* are three in number. The medial one passes from the lateral surface of the first cuneiform to the adjacent angle at the base of the second metatarsal bone. The intermediate one passes from the medial surface of the third cuneiform bone to the adjacent angle at the base of the second metatarsal bone The lateral one passes from the lateral surface of the third cuneiform bone to the adjacent side of the base of the fourth metatarsal bone. *Movements*.—These are arthrodial joints permitting of gliding movements only.

VIII. **Intermetatarsal Articulations**.—The second, third, fourth, and fifth metatarsal bones are connected at their bases by dorsal, plantar, and interosseous ligaments. The *dorsal* and *plantar ligaments* connect the dorsal and plantar surfaces respectively of the bases of the contiguous bones. The *interosseous ligaments* pass between the adjacent rough sides of the bases of these bones.

The *transverse metatarsal ligament* connecting the heads of of all the metatarsal bones has been already described. *Movements*.—These are arthrodial joints permitting slight gliding movements only.

The **Synovial Strata** of the intertarsal and tarsometatarsal articulations are six in number (Fig. 182): the *first* lies in the talocalcaneal articulation, the *second* lies in the talo-calcaneo-navicular articulation; the *third* is placed in the calcaneocuboid articulation; the *fourth* is in the cuneonavicular articulation and extends (*a*) to the cuneocuboid articulation, (*b*) to the joints between the cuneiform bones, (*c*) to the joints between the second and third cuneiform bones and the bases of the second and third metatarsal bones; this is again prolonged distally between the adjacent surfaces of the bases of the second, third and fourth metatarsal bones; the *fifth* is between the first cuneiform bone and the base of the first metatarsal bone; the *sixth* is between the cuboid and the bases of the fourth and fifth metatarsal bones.

IX. **Metatarsophalangeal Articulations**.—These are condyloid articulations the head of the metatarsal bone fitting into the concavity at the base of the proximal phalanx. Each of these joints presents an accessory plantar ligament and two collateral ligaments like the corresponding joints of the hand. The collateral ligament is attached proximally to the posterior tubercle on the side of the head of a metatarsal bone and distally to the corresponding side of the base of the proximal phalanx. There is no dorsal ligament in these joints—its place being occupied by the expansion of the extensor tendon on the dorsum. Each joint is lined by a separate synovial stratum. *Movements*.—Flexion, extension, abduction, adduction and circumduction are permitted in these joints.

X. **Interphalangeal Articulations**.—These are hinge-joints. Each of these joints presents a plantar and two collateral ligaments like the corresponding joints of the fingers and is lined by a separate synovial stratum. The dorsal ligament is replaced by the expansion of extensor tendons. *Movements*.—Flexion and extension are the only movements permitted in these joints.

Arch of the Foot.—The student should note that the foot is so constructed as to present two curvatures or arches, an antero-posterior or longitudinal and a side to side or **transverse arch**. This arch is maintained by the shape of the individual bones aided by the muscles, tendons, ligaments and fasciæ. The *longitudinal arch* has its posterior pier formed by the calcaneus. Its anterior pier is formed medially by the talus, navicular, three cuneiform, and the first three metatarsal bones. Laterally it is formed by the cuboid and the last two metatarsal bones.

The summit of the arch is formed by the superior surface of the talus. The arch rests behind on the calcaneus and in front on the heads of the metatarsal bones. This longitudinal arch is maintained by the plantar calcaneonavicular ligament, the long plantar ligament, the plantar calcaneocuboid ligament, the tendon of the tibialis posterior, the small muscles of the sole of the foot and the plantar aponeurosis on the plantar aspect of the sole of the foot. The tonic pull of the tibialis anterior which is inserted into the first cuneiform and the base of the first metatarsal bone also helps to maintain the arch. The *transverse arch* is most marked at the tarsometatarsal articulations and is maintained by the tendon of the peronæus longus, the dorsal plantar and interosseous ligaments of the tarsus and the adductor hallucis muscle. Its summit is formed by the talocalcaneal articulation.

TABLE OF THE ARTERIES OF THE INFERIOR EXTREMITY

External iliac — See Table of Abdomen

is continued as

Femoral ..
- 1. Superficial epigastric
- 2. Superficial iliac circumflex
- 3. *Superficial external pudendal*
- 4 Deep external pudendal
- 5 Muscular
- 6. Profunda femoris
  - 1. Lateral femoral circumflex
    - 1. Ascending
    - 2. Descending
    - 3 Transverse
  - 2. Medial femoral circumflex
    - 1. Muscular
    - 2 Acetabular
    - 3. Superficial
    - 4. Deep
  - 3. Perforating
    - First
    - Second
    - Third
  - 4 Muscular
- 7. Highest genicular
  - 1 Saphenous
  - 2. Musculoarticular

is continued as

Popliteal
- 1. Cutaneous
- 2. Muscular
  - Superior
  - Sural
- 3. Genicular ..
  - Superior . Medial, Lateral
  - Middle
  - Inferior: Medial, Lateral
- 4 Anterior tibial
  - 1. Anterior tibial recurrent
  - 2 Posterior tibial recurrent
  - 3 Muscular
  - 4. Anterior medial malleolar
  - 5 Anterior lateral malleolar
  - is continued as Dorsalis pedis
    - 1. Lateral tarsal
    - 2. Medial tarsal
    - 3 Arcuate .. 2nd, 3rd, 4th dorsal metatarsal
    - 4 First dorsal metatarsal
    - 5 Deep plantar .. 1st plantar metatarsal
- 5. Posterior tibial ..
  - 1 Fibular
  - 2 Peroneal ..
    - 1. Muscular
    - 2. Nutrient
    - 3 Perforating
    - 4. Communicating
    - 5. Lateral calcaneal
  - 3. Nutrient
  - 4. Muscular
  - 5. Communicating
  - 6. Posterior medial malleolar
  - 7. Medial calcaneal
  - 8. Medial plantar — Superficial digital branches
  - 9. Lateral plantar . forms Plantar Arch
    - Perforating
    - Plantar metatarsal

SUPERFICIAL VEINS OF INFERIOR EXTREMITY

1. Great saphenous vein receives
   - 1. Dorsal Venous Arch receives — Dorsal metatarsal veins receive — Dorsal digital veins receive — Intercapitular veins
   - 2. Medial dorsal digital vein of great toe
   - 3 Superficial veins of leg
   - 4 Superficial veins of thigh — Accessory saphenous vein.
   - 5. Superficial iliac circumflex
   - 6. Superficial epigastric
   - 7 Superficial external pudendal

   Communicates with
   - 1 Small saphenous vein
   - 2 Anterior tibial vein
   - 3. Posterior tibial vein

2. Small saphenous vein receives
   - 1. Dorsal Venous Arch
   - 2. Lateral dorsal digital vein of little toe
   - 3. Superficial veins of leg

TABLE OF THE NERVES OF THE INFERIOR EXTREMITY

- **Lumbar plexus** gives off ..
  - 1. Iliohypogastric .. .. } See Table of Abdomen
  - 2. Ilioinguinal .. .. } See Table of Abdomen
  - 3. Genitofemoral .. .. } See Table of Abdomen
  - 4. Lateral femoral cutaneous .. .. } See Table of Abdomen
  - 5. Femoral ..
    - 1. To iliacus
    - 2. To upper part of femoral artery
    - 3. Anterior division ..
      - 1. Intermediate cutaneous
      - 2. Medial cutaneous
      - 3. Muscular
    - 4. Posterior division ..
      - 1. Saphenous
      - 2. Muscular
      - 3. Articular
  - 6. Obturator ..
    - Anterior
    - Posterior
  - 7. Accessory obturator

- **Sacral plexus** gives off ..
  - 1. To quadratus femoris and gemellus inferior .. } See Table of Abdomen
  - 2. To obturator internus and gemellus superior.. } See Table of Abdomen
  - 3. To piriformis
  - 4. Superior gluteal ..
    - Superior
    - Inferior
  - 5. Inferior gluteal
  - 6. Posterior femoral cutaneous
    - 1. Gluteal
    - 2. Perineal
    - 3. To back of thigh and leg
  - 7. Sciatic
    - 1. Articular
    - 2. Muscular
    - 3. Tibial ..
      - 1. Articular
      - 2. Muscular
      - 3. Medial sural cutaneous
      - 4. Medial calcaneal
      - 5. Medial plantar
        - 1. Cutaneous
        - 2. Muscular
        - 3. Articular
        - 4. Proper digital of great toe
        - 5. Three common digital
      - 6. Lateral plantar
        - Superficial
          - Proper digital
          - Common digital
        - Deep
    - 4. Common peroneal
      - 1. Articular
      - 2. Lateral sural cutaneous
      - 3. Peroneal anastomotic
      - 4. Superficial peroneal
        - 1. Muscular
        - 2. Medial dorsal cutaneous
        - 3. Intermediate dorsal cutaneous
      - 5. Deep peroneal
        - 1. Muscular
        - 2. Articular
        - 3. Medial terminal
        - 4. Lateral terminal

Pudendal plexus .. } See Table of Abdomen
Coccygeal plexus .. } See Table of Abdomen

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